The AMSAT Journal

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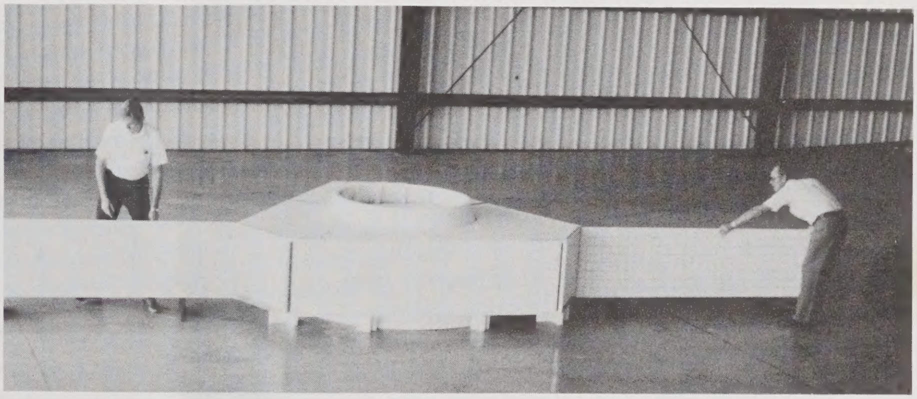
Minutes of the *AMSAT* Phase 3D Experimenter's Meeting

ORLANDO, FLORIDA November 1 - 3, 1991



Stan Wood, WA4NFY, and Tom Phillips, KC4ZVE, provide perspective to the size of the full-scale mock-up of Phase 3D. Dick Jansson, WD4FAB Photo.

By: Dick Daniels, W4PUJ

Opening Remarks:

This third international meeting of the Phase 3D Project experimenter team was convened by Dick Daniels, AMSAT-NA Phase 3D Project Manager, who welcomed the attendees and suggested that the principal focus for this meeting should be the spacecraft structure and basic housekeeping functions. He then turned to Karl Meinzer for a report on the status of relations with the European Space Agency (ESA).

The ESA Interface: Karl Meinzer

Meinzer noted that since the previous experimenter's meeting at Marburg in May 1991, ESA made a firm commitment in July to the flight of the Phase 3D spacecraft on the second of the Ariane V test flights, currently scheduled for October 1995. Working relationships have now been established with the APEX, the ESA office responsible for the experimental payload package on the Ariane V test flight, and we have been provided with specific payload constraints and requirements. The configuration wherein our spacecraft is built around the interface adaptor was selected and a payload weight limit of 500 kg, including the adaptor, established. While not complete, we have already received extensive

(continued on page 4)

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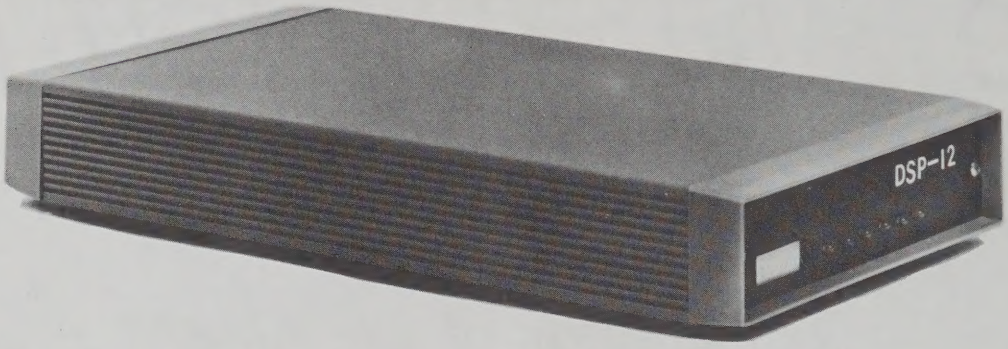

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Apogee View

The State of *AMSAT*

By: Bill Tynan, W3XO
President AMSAT-NA

This is the season of the year when it is customary to take stock of current activities and engage in a little predicting of what is to come. This is particularly appropriate with the recent changes in some of AMSAT's key personnel.

First, as most know already, I was asked to assume the Presidency of AMSAT. In accepting this position, I made it expressly understood that I was doing so for a limited time. I retired after 36 years in the U.S. defense program, and wasn't looking for other full time employment. Nevertheless, I have been with this organization since it began and want to see it succeed. If I can contribute to that goal by increased effort on my part over the next year or so, I will do so.

Ray Soifer W2RS, another founding member, accepted the Executive Vice Presidency on similar terms. Unlike me, Ray is not retired. He has a very responsible job at one of Wall Street's leading investment houses. So, his time is severely limited. Because of my desire to lead a more peaceful life with time to travel, ham and listen to music; and because of Ray's demanding schedule, neither of us believe that we can take on these duties for an indefinite period of time. Thus one of the major tasks which both of us will tackle is that of looking for suitable people to be our successors.

As stated in the ANS bulletin which announced the new officers, the reason I was asked by the Board to become President was to enable Doug Loughmiller to spend one hundred percent of his time on fund raising activities. As you may recall, Doug had become President in late 1988. Two years later, the Board, seeing a need for increased fundraising effort in connection with the impending Phase 3D project, accepted his proposal to also become a full time AMSAT employee with the title General Manager. Customarily, that title carries with it the connotation of day to day running of an organization. Having one person as both President and General Manager led, not unexpectedly, to a number of problems in terms of defining the duties of the paid General Manager and those which the President should accomplish as an unpaid volunteer. It also became obvious that loading one person down with administrative responsibilities, whether as President or General Manager, was not permitting him to put sufficient effort into the all-important job of fund raising. With the Board's determination that The Radio Amateur Satellite Corporation, known internationally as AMSAT-NA would accept an active role in the Phase 3D Project, the need to mount a major fund raising effort became even more imperative.

Thus, it was determined by the Board that Doug should work exclusively on fund raising and that I, as President with help from Ray, Martha and the other very capable officers, should handle the rest of AMSAT's affairs. This decision led to Doug's being named Chairman of the Board. There were two reasons for this move. One was that he does a good job of conducting Board meetings and the other is that a fund raiser requires a title which conveys the message that he or she represents management of the organization and is not merely a salesperson. Doug was also given the title of Executive Director, which is the title under which he is paid. It wouldn't do to have the Chairman of the Board paid if the President is not. And, I have always insisted that it is unwise for AMSAT to have a paid President.

That off my chest; on to where our organization stands right now. First the good news. As Doug's first major accomplishment in the fund raising area, he produced a very impelling letter to our members asking for contributions and pledges in support of our commitment to the Phase 3D Project. All of you should have received your copies by now. I urge each and everyone of you to respond with a contribution and a pledge to contribute in each year of the expected five years it will require to design, build and prepare this ambitious satellite for launch. Please try to pledge as much as you can afford. The very future of the Amateur Space Program depends on your response. As an inducement, I am initiating a Phase 3D Project Newsletter. It will be sent quarterly to all of those who have pledged the minimum amount of $36.92 per year or more. This new publication will contain detailed information on how the Project is going - both its accomplishments and set backs. While general information on Phase 3D will be available to all members through *The*

(continued on page 29)

AMSAT Experimenter's meeting

(continued from page 1)

interface documentation from APEX. Bernard LaCoste, the ESA manager responsible for the Phase 3C mission, will have the same role for Phase 3D. He has already visited the Marburg group to initiate detailed discussions concerning testing requirements and interfaces with the launcher and the other payloads.

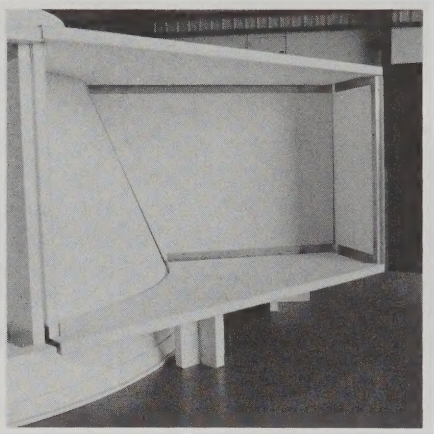
Meinzer next reported on an October 18, 1991 meeting with representatives of APEX and Cluster, the multiple spacecraft project, two of which will be carried by the Phase 3D adaptor/spacecraft. Despite the fact that the announced ground rules for management relationships were that all payload groups would interface through the APEX office, the Cluster group at this meeting exerted strong pressure to establish a direct working relationship with AMSAT. Karl argued to retain the original arrangements and, in the end, his position prevailed. He anticipates continuing close attention from the Cluster project management team, but all formal interaction will be conducted through the APEX Office. One technical issue that surfaced at the meeting was the claim by the Cluster team that their lifting fixture was not qualified to lift the total mass of the stack including Phase 3D and that it could not be requalified. An action was taken to investigate ways of dealing with the problem. Another meeting has been scheduled for December 12, in Marburg.

Summarizing the current status of technical development, Meinzer said that most of the effort was being directed toward design of the conical adaptor. He felt that we had a good design, but noted that we were behind schedule on the Finite Element Analysis (FEA) that is required by ESA. The deadline for this has been extended to December 15. Karl's initial calculations confirm that our current design is more than adequate to support the required mass of 3.5 metric tons. Buckling stress limits still need to be investigated. AMSAT-DL is working to identify simple solutions to fabrication problems while Dick Jansson is working the thermal and structural analysis.

The Spacecraft Structure: Dick Jansson

Overall Configuration:

Next, Dick Jansson went through a series of viewgraphs that showed the evolution in design of the spacecraft structure since the Marburg meeting in May that led to the triangular shape represented by the full-scale mockup on display in the meeting room. He explained the reasons that drove the design from a multi-sided configuration that resembled that of the Millennium Falcon spaceship featured in the Star Wars science fiction film to the three-sided configuration that now appears to be the best approach. He asked if we should continue to use the "Falcon" name for the spacecraft, and, after some discussion, it was agreed that those who wished to could do so.



This shows one of the six cavernous areas in the spacecraft bus to be filled with hardware. The ''ceiling'' height in the compartment is 650mm (over 25 inches). You could put 4 Microsats inside this area and still have room. WD4FAB Photo.

The configuration proposed by Jansson was a modular structure that could be disassembled into three segments plus the conical adaptor for transport. The bi-propellant propulsion system, including propellant tanks, thruster and all associated plumbing, was to be assembled as a unit and mounted inside the conical adaptor. Solar arrays were designed for 8 × 8 cm cells with heat pipes embedded in the body-mounted solar array conductively connected to extensions in the other side walls to remove heat from the side facing the sun. Meinzer reminded everyone of the need for a separate propellant tank for the electrical thruster being proposed for orbit trim and station keeping.

The Conical Adaptor:

The conical adaptor is required to act as both the Phase 3D structure core and the interface between the launch vehicle and a stack of two Cluster spacecraft. The configuration utilizes top and bottom machined aluminum rings (or frames), with respective diameters of 1194 mm and 1920 mm, on a conical body formed from segments of 5 mm sheet aluminum. Stiffening of the conical body is to be accomplished by stringers.

Jansson reported that all vendors had recommended that the ring blanks be formed from 7075 aluminum alloy using a rolled forging technique that provides a circumferential grain pattern. Also recommended is an approach where the rings will be initially machined to rough specifications, then riveted to the conical adaptor, with final machining to tolerance done on the assembled adaptor. This is to avoid problems of warping finished rings in the assembly process. The Weber State University team has been handling the contacts with vendors and is proposed by AMSAT-NA to fabricate the conical adapters. FEA analyses of the adaptor are being conducted by groups at Weber State, Brigham Young University, and the U.S. Naval Academy, but none have been completed. One missing piece in the puzzle is that ESA has not yet fully defined the dimensions of the lower ring.

Meinzer said the Marburg group had also been investigating a fabrication technique for the conical body that used 32 segments with upturned edges and riveted along the matching edges to provide the equivalent of stringers. He further reported that they had been in contact with a machine shop in the Marburg area that had indicated they could do the machining of the rings at a very reasonable price. After discussion, the following steps were agreed to:

Decisions:

1. The approach proposed by AMSAT-DL for fabrication of the conical adaptor was adopted.
2. AMSAT-NA will proceed with procurement of three sets of forgings for upper and lower conical adaptor rings plus two forgings each to provide for fabricating upper and lower mounting rings for the test fixture attachment and ground transport. Ten forgings in all will be procured.
3. One set of forgings for flight rings and for ground attachment fixtures will be shipped to AMSAT-DL for machining and use in fabricating one flight-quality conical adaptor.
4. The other two sets of forgings will be retained at Weber State for machining and fabrication of one or more flight quality conical adaptors.
5. AMSAT-DL will work with ESA to complete definition of the lower ring dimensions.

Structure Fabrication Materials and Techniques:

Jansson described in detail his proposed approach for fabricating the spacecraft structure from honeycomb panel material similar to the approach investigated during the Phase IV spacecraft study. He showed a series of viewgraphs that demonstrated the techniques to be used for closing the edges, attaching the individual pieces, and providing attachment points for equipment mounting. The result is a relatively light, very rigid structure with good thermal characteristics. Heat pipes fabricated into the front and side panels would be used to carry heat away from the body-mounted solar array to the other two sides for radiation to space from the cold sides. Jansson proposed using a "piano hinge" technique for joining the three modules of the spacecraft.

In the discussion that followed Jansson's presentation, Meinzer questioned the need for such extensive use of honeycomb material in fabricating the structure. He suggested that stiffness was not that much an issue and that fabrication using sheet aluminum and stringers as had been done with the earlier Phase 3 spacecraft would be easier and result in a lighter structure. At the same time, he conceded that sheet metal was not good where large, flat areas were involved and proposed that some combination of honeycomb and sheet metal might be the way to go.

Decision:

1. The triangular spacecraft bus configuration was adopted as the baseline.

Actions:

1. AMSAT-NA and AMSAT-DL to collaborate in their efforts to investigate structure fabrication techniques to utilize the optimum combination of honeycomb vs. "aircraft" panel to take advantage of the strengths of both materials. Final decisions on structure design and fabrication to be made at the May Marburg meeting.
2. AMSAT-DL to investigate off-center location of the arm center walls to assist in module placement.

Thermal Design: Dick Jansson

An extensive discussion of the proposed use of heat pipes, their high cost and the difficulties of handling the panels with the heat pipes protruding from their edges led into a presentation by Jansson of the overall thermal design. He presented a series of charts that showed the results of an extensive computerized analysis involving 60 - 70 nodes and beta angles from 0 to 45 degrees. With the heat pipe configuration proposed, and assuming the need to dissipate an average of 250 watts produced within the spacecraft, Jansson was able to demonstrate very favorable steady-state thermal conditions. With the continuing concern about the cost and complexity of the heat pipes, Jansson was asked to look at additional options assuming maximum dissipation of 150 watts and minimum of 20 watts. Spacecraft compartments are to be closed on all occasions with such closures being load carrying members and thermal control surfaces.

Actions:

1. Jansson to examine spacecraft thermal analytic model using four heat pipes in each radiator panel and eight heat pipes in the solar panel in alternating arrangements of four pipes exiting each end of the panel.
2. Examine spacecraft thermal analytic model using only two deployed solar panels with panel on Side 1 as a thermal control surface only.
3. Examine model as in Item 2, with Side 1 as a high temperature solar panel thermally isolated from the bus.

Electronic Module Design and Fabrication: Dick Jansson

Jansson presented designs for a family of standard electronic modules ranging from 100 × 200 mm to 200 × 300 mm and heights of 25, 32, and 38 mm. The fabrication approach was similar to that used for modules used in the earlier OSCAR satellites with modifications to correct known deficiencies. Mounting of the boards within the boxes was proposed to use an improved design of the "traditional" Delrin blocks. Continued use of the fiberglass rails for mounting the electronic modules was proposed. After discussion the following decisions were made and actions directed.

Decisions:

1. Modules will be standardized for footprint only, not height.
2. Fabrication of modules to be the responsibility of the individual experimenters or groups.
3. Fabrication of the Delrin blocks and fiberglass mounting rails will be centralized.

Actions:

1. AMSAT-NA to fabricate and distribute the Delrin mounting blocks.
2. Jansson to redesign and arrange for fabrication of fiberglass mounting rails. Rails to be deepened to 12 mm to allow hardware clearance and rail flanges to be widened. Rail length should be 584 mm in finished form. Drilling template to be modified to reflect the new mounting hole dimensions.

Propulsion Systems:
Dick Daniels, Dick Jansson, Karl Meinzer

Bi-propellant Main Propulsion System:

Dick Daniels proposed that the main propulsion system should be essentially the same as the one used in OSCAR 13, based on the MBB 400 N thruster and with new tankage to accommodate the larger volume of propellants required. He has contacted the company that previously provided the solenoid valves used for helium pressure regulation in the previous design and found them still to be available. Whether or not they can be secured through donation this time is still in question. Sources of fill and drain valves need to be found since all those available from MBB were used for the OSCAR 13 mission. Jan King offered to help with identification of suppliers for propulsion system components.

Dick Jansson reported that he had investigated the Lockheed Company as a source of propellant tanks and found that while excellent tanks are available, the costs are beyond our reach. He then identified and followed up on another source of tanks, Structural Composites Industries. They appear to have tanks of the size we require and at a price that, while still high, is in a range we might afford. These tanks would be provided without propellant management devices, which would have to be separately fabricated or procured. A tank of the proper volume for high-pressure helium storage still needs to be found. Meinzer suggested that a larger tank that would only have to be

The intensive design meeting. L-R Horizontally polarized: Jan Kin, W3GEY, and Dick Daniels, W4PUJ, (Both obviously unable to stand the pressure of McGwier's pontifications); Bob McGwier, N4HY, dutifully lecturing Doug Loughmiller, KO5I, (back to camera) and Werner Haas, DJ5KQ; Jon (where's the beer?) Bloom, KE3Z; hidden behind Jon and seated is Rosemari Haas witnessing this spectacle in amazement; and Tom Clark, W3IWI, (surely needing the firm support of the counter). Jyri Putkonen, OH7JP, Photo pressurized to 200 bar would be more desirable than the 400 bar tank used previously. There was agreement that at the price indicated these propellant tanks should be considered strong candidates. The issues of propellant management devices and a helium tank remain to be resolved.

Meinzer said that while no commitment had been yet made by MBB to donate another 400 N thruster, he remained confident that something could be worked out at the appropriate time. Daniels pointed out with the 400 N thruster located in the center of the conical adaptor, the exit cone was likely to project beyond the current lower spacecraft envelope and that this needed to be discussed with the APEX office.

The Messerschmid Electric Propulsion System:

Meinzer next reported on a low thrust, high efficiency thruster under development at the University of Stuttgart under the direction of Ernest Messerschmid, the German astronaut who flew on the D-1 Spacelab mission. This propulsion system uses electrical energy to heat and expel ammonia propellant. This motor is designed to produce 100 mN of thrust with a fuel flow of 30-50 mg/sec. AMSAT-DL is assisting this effort by designing the power conditioning units. Karl proposed carrying this system as a means of making fine orbit adjustments for "station keeping". About 60 kg of ammonia is required.

Actions:

1. Jansson to locate a Helium storage tank for 20 liters storage at 200 bar.
2. Daniels to locate sources of fill and drain valves and other hardware required for the Propellant Flow Assembly.
3. Meinzer to approach MBB at the appropriate time to secure another 400 N thruster and the necessary propellant handling support.
4. Meinzer to discuss with the APEX office possible penetration of the 400 N thruster below the current spacecraft envelope.
5. AMSAT-DL continue to support development of the electric propulsion system. Find out if motor uses liquid or gaseous ammonia.
6. Jansson to include in the spacecraft design a tank for 30 - 50 kg of ammonia for the electric propulsion system.

Environmental Testing and Test Plans:

Static Testing Requirements:

Meinzer reported that ESA will require a static test of our structure that involves applying a 15 ton force to it. A fixture is needed to support this test. The Cluster people have urged a similar test of the flight model, but Meinzer does not believe the APEX office will require this.

Dynamic Testing Requirements:

Both sinusoidal and acoustic testing is required by ESA, but no random vibration tests. It is not clear what facilities might be available for acoustic testing, a requirement we have never had before.

Thermal Vacuum Tests:

It was agreed that while a thermal vacuum test is not required by ESA, it is essential in order to assure that all systems will function in the space environment and for providing data on outgassing characteristics. Jan King pointed out that it has also been the best opportunity for all-up function testing of the complete spacecraft. It was recognized that the size of the Phase 3D spacecraft significantly reduced the number of facilities capable of accommodating it and increased the costs of conducting a test of any length.

Test Units:

According to the current schedule, ESA requires AMSAT to provide a structural mockup of the spacecraft by mid-1992. The mockup is a structure that is mechanically, but not electrically, representative of the flight spacecraft. Karl will argue that this is not possible to meet since the lower interface has not yet been defined. While he believes that it is likely that this requirement can be delayed, he urged that we internally plan for producing this mockup by mid-1992. He said that ESA was planning some mechanical tests of the Cluster spacecraft in March 1992, but that holding to that schedule was unlikely.

Actions:

1. King to investigate the availability of testing facilities in the Denver Colorado area.
2. Smith to investigate the availability of facilities in Utah.
3. McGwier to contact GE-Astro in New Jersey.
4. Daniels and Tom Clark to see if GSFC could provide any support.
5. Putkonen to see what might be available in Finland.
6. Meinzer to contact the MPE organization at Garching to see what facilities might be available in Europe. Also to negotiate with ESA for substitution of a random vibration test for the acoustic test.
7. All to report back by the end of 1991.

Dick Jansson, WD4FAB, always talking, even to charming guest Mary Wood.
OH7JP, Photo

Antenna Development: Dick Jansson, Stan Wood

Dick Jansson and Stan Wood began the discussion of antennas with a report on what was being done in the Orlando, Florida area. Stan had fabricated a number of test antennas to investigate different configurations for the 2-meter band including deployable turnstiles mounted on the top of the spacecraft and half yagi elements located on the sides of the spacecraft and driven by distributed amplifiers. For 70 cm, Dick Jansson described a possible configuration of 7 patch antennas, 6 in a circle and one in the center that he calculated would have about 15 dB gain. The Orlando group had set up an antenna test range, tested some configurations already and were prepared to continue testing a wider variety of antennas.

Tom Clark suggested that, with a proper matching arrangement, the deployed solar arrays could be used as the 10-meter antennas.

These proposals led to an extensive discussion of the pros and cons of microstrip antennas and led to the strong recommendation that additional space above the spacecraft top surface be negotiated to permit more turnstile antennas. A number of possible configurations for the top of the spacecraft were proposed, but no conclusions were reached. Jan King proposed that the design metric should be that the received signal should not vary by more than 3 dB throughout the orbit. Jyri Putkonen reported that the Finnish group was planning a 2 x 2 horn array for the X-band experiment with microcomputer control of the beam shape. He continued by giving an overall progress report on the design and development of the X-band transmitter.

As part of the antenna discussions, Tom Clark proposed that all local oscillators in the spacecraft be controlled by a high-precision master clock the frequency of which could be controlled by digital synthesis to offset the radial component of Doppler shift as seen by stations on the ground.

At the conclusion of the antenna discussions, the following actions were taken:

Actions:

1. Meinzer to negotiate additional space above the spacecraft top surface to permit use of turnstile antennas.
2. Jansson and Wood to continue to investigate a variety of antenna configurations including:
   a. Gamma match feeding of the solar arrays for 10 m.
   b. Three active element arrays at 60 degree orientation with element root ends located in the -X end of arm 2.
   c. Seven element patch antennas for 70 cm. Examine the use of recessed slot antennas as alternatives.
   d. Four to seven CP horn, recessed turnstile, or slot antennas for 24 cm and 13 cm.
3. Tom Clark to further develop the master clock concept.

Solar Arrays: Joe Capitano

Joe Capitano introduced the company he represents, Applied Solar Energy Corporation, as the oldest solar cell company in business, and distributed samples of the 8 × 8 cm solar cells planned for use in Space Station Freedom. He then proceeded with a mini-tutorial on solar cell technology covering both silicon and gallium-arsenide cells. With the current state of technology gallium-arsenide gives a 10 - 20% improvement over silicon. Gallium-arsenide is also more resistant to radiation damage, and produces good power output at higher surface temperatures than silicon. Capitano gave the current price of silicon cells, at the raw cell level, as approximately $80/watt and for gallium-arsenide as $300/watt, but added that when fabrication costs are taken into account, the price difference is much less. He went on to say that his company had, or was anticipating, several major contracts for solar arrays and that he had discussed with Jan the possibility that

This bunch never stops eating! L-R: Tom Clark, W3IWI, Karl Meinzer, DJ4ZC, Karen Meinzer, Bob Woods, W5QPD, Margaret Müeller and Konrad Müeller. OH7JP, Photo

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they might be able to provide gallium-arsenide cells to AMSAT that had been selected out for these contracts, but still had efficiencies comparable to silicon cells. The company was definitely interested in working with AMSAT to provide the Phase 3D solar arrays at as low a cost as possible.

In the discussion that followed Capitano's presentation, questions were asked about the efficiency of gallium-arsenide cells at 80 degrees C, the temperature of the body mounted solar array without heat pipes. Capitano said that the cells would easily operate well at that temperature. This fact plus their resistance to radiation damage made use of the 5.5 X 6.5 cm gallium-arsenide cells a very attractive option. At the conclusion of the discussion, it was agreed that this option should be pursued and the following actions were assigned:

Actions:

1. Capitano to provide a copy of the JPL solar cell book to King for Meinzer.

2. Capitano to provide King with samples of gallium-arsenide cells for testing to determine RF characteristics. (capacitance ?, function as a rectifier ?, generate intermod ?)

3. Jansson to investigate the placement of 5.5 × 6.5 cm cells on the solar panels.

The Spacecraft Housekeeping Functions: Jan King

The Power Unit:

King proposed that the Phase 3D spacecraft power system be the same basic design as the ones used in the previous Phase 3 spacecraft with changes only to deal with the higher power levels. This was agreed. Meinzer suggested the need to particularly look at the switching circuits in the Battery Charge Regulator (BCR) and suggested that electronic fusing should be used in all boxes rather than "mechanical" fuses.

Batteries:

Possible sources of batteries was discussed next. A 34 amp-hour, 44 cell nickel-hydrogen test battery with limited test time on it appears to be a strong candidate if donation can be arranged. Also, it was reported that Larry Kayser had volunteered his group to select cells for a nickel-cadmium battery. Meinzer recommended that 28 volts be selected as the battery voltage with a limited number of other voltages to be centrally provided. Beyond that, other voltages will have to be derived by experimenters within their boxes.

Decision:

1. The same power regulation system be used for Phase 3D as was used in the previous Phase 3 spacecraft.

Action:

1. Meinzer to recommend additional bus voltages to be centrally generated and distributed.

Power Connectors:

King pointed out the need to identify connectors capable of carrying the higher voltages/currents to be used in the Phase 3D spacecraft.

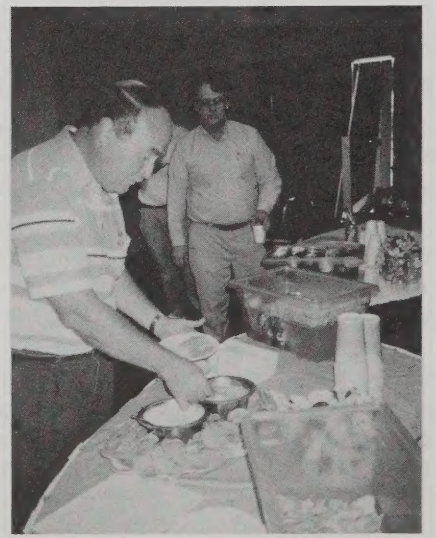
Action:

1. AMSAT-DL to investigate flat pin connectors used in automobiles.

Command, Control, and Telemetry:
Bob McGwier, Peter Guelzow

An extensive discussion of the pros and cons of centralized versus distributed command and control with a number of strong advocates of the distributed approach and others, while not opposing this approach, raising reliability questions about dependence on the "LAN" approach. King said that his group at Orbital Sciences Corporation had made an extensive investigation of microcontrollers and had selected the Intel 87C196KC for their spacecraft applications. They were currently doing tests to investigate the radiation hardness of this device.

Peter Guelzow next gave a presentation on the approach proposed by himself and Bob McGwier. This involved a serial "token ring" design backed up by a hardware command decoder in each box as a backup to permit initial testing of each box before committing it to the ring. Meinzer suggested a "star" design as an alternative interconnect to avoid problems if the serial line was interrupted. Clark favored the ring approach with hardware capability to bypass problem boxes, but suggested considering an "ethernet" approach. He also raised a question about adequacy of the number of bits to be available and the number of digital and analog signals that could be processed by the central computer. McGwier pointed out that design of a standard embedded controller required some assumption of the number of signals to be processed. After some discussion, the following was established as a design assumption:



And more eating! L-R Al Brinkerhoff, WB5PMR, loads his plate while being supervised by Tom Clark, W3IWI. OH7JP, Photo.

Decision:

1. The data distribution system should provide for 32 digital lines and 8 analog lines.

Actions:

1. McGwier and Guelzow to have a completely defined system design for presentation at the May 1992 Marburg meeting.

2. McGwier to complete design and fabrication of an embedded controller board to be used as the communications node in all experiment boxes.

3. Meinzer to check the Red Book to assure that there are sufficient lines to support the BCR.

4. King to report on investigations being done at OSC on new RAM devices.

The Communications Systems: Jan King

King stressed the need for decisions on how the switching between transponder units will be accomplished. Most important to the transponder designers was to know what I.F. frequency or frequencies were to be used. In the discussion that followed the issue of the need for frequency agility was discussed, what functions the I.F. matrix switch should be expected to perform, how to handle AGC, and the incorporating of a master clock. Regarding the output of a master clock, Clark proposed 1 volt RMS into 50 ohms. Meinzer suggested dropping this to .2 volt to reduce power consumption. At the conclusion of this discussion, the following decisions and actions were established.

Decisions:

1. The common I.F. frequency to be 54 MHz.

2. AGC design should assume -60 dBw for full transmitter output (further decision needed on voltage range of AGC signal. Earlier design used 0 - 8 volts. Newer CMOS devices are designed for 0 - 5 volts).

Action:

1. Clark to investigate sources for high-stability master clock.

Orbital Planning: Jan King

King presented a joint paper he and Stephen Eckert had prepared based on the discussions at the 1991 Marburg Meeting that investigated the properties of a high inclination, elliptical orbit that gave good coverage to all locations on the earth over a three-day period. He pointed out that although the coverage provided by this orbit is excellent, the high apogee and inclination result in an orbit that is very sensitive to perturbations and will require an on-board, propulsion capability to maintain the proper resonant properties. Additional study is needed to determine the amount of delta V that will be required over the lifetime of the mission.

Tom Clark followed King's discussion with a summary of the paper he had prepared looking in detail at the effect of perturbations on the OSCAR 13 satellite orbit that will result in its entry into the atmosphere in 1997. Clark's data confirmed the sensitivity of "Molniya" orbits to perturbation and the difficulty of long-term planning of chaotic orbits. He made the point that while it was possible to accurately predict the long-term implications of any orbit given a defined set of initial conditions, it was impossible to go backward from a desired orbit to identify the required initial conditions. Following his OSCAR 13 discussion, Clark provided graphical data on early looks at the orbit proposed for P3D that further confirmed King's conclusions that on-board propulsion would be required to maintain the orbit.

It was agreed that while some of the AMSAT volunteers had the capability to do the required complex orbital calculations, additional in-house capability needed to be developed.

Attitude Determination and Control:
Meinzer, King, Clark

Momentum Wheels:

Meinzer reported that he done sufficient analytical work to convince himself that there were no fundamental problems with the design and fabrication of magnetically suspended momentum wheels. The driving mechanism, similar to an asynchronous motor, should theoretically draw very little power. Three wheels will be required weighing about 6 kg with a maximum spin rate of 3,000 rpm. Estimated size for each is a box 12 inches square and 3 inches high. The design draws on information in an ESA paper by Robinson.

Action:

1. Meinzer to revisit his earlier calculations taking into account the new structure configuration.

Sensors:

While King reported little progress in identifying specific sensors, he said that he was keeping in touch with Jim Fallon, an expert in this field, and that he had a high degree of confidence that Fallon would be willing to work with AMSAT to develop both Earth and sun sensors. If no other sun sensor can be located, King reminded the group the ADCOL sensor from the Phase 3A mission was still available.

Magnetorquers:

Meinzer said that the triangular spacecraft structure made incorporation of magnetorquers relatively easy. He saw no problems with design or implementation.

Attitude Reference Using RF Systems:

Tom Clark next presented his proposal for determining spacecraft attitude using signals from the Global Positioning Satellite (GPS) network. His proposal is to mount GPS antennas at three points on the top and bottom of the satellite and use interferometric techniques to process the GPS satellite transmissions and derive very accurate pointing information and state vectors. Clark said that if a synthesizer controlled oscillator was used to take out the Doppler shift due to the motion of the Phase 3D spacecraft, existing commercial GPS receivers could be used on the spacecraft. As a backup to the GPS system Clark proposed I.R. sensors similar to the ones flown on the AMSAT microsats arranged in a hemispherical configuration.

In the discussion that followed Clark's presentation, King reported that OSC had flown a six channel GPS receiver on the Pegasus launcher in parallel with the primary guidance system and that it had given very good data. Meinzer said that Matjaz Vidmar YT3MV was doing work with GPS reception and might be able to assist in this project. Jay Smith suggested a CCD camera with a fisheye lens under development by Weber State as another possibility for a backup attitude reference system. King said that his group at OSC was doing testing on a single-board GPS receiver and might be able to make units available. He proposed they check out the radiation sensitivity of the unit. All agreed that the proposal had merit, but that considerably more work will be needed to demonstrate the feasibility of the GPS system. Meinzer pointed out that with the incorporation of an inertial platform using gyroscopes, the need for frequent updates would be reduced. King said that Gordon Hardman was interested in investigating the "wineglass" gyroscope technique. At the end of the discussion, the following actions were assigned.

Actions:

1. Clark to develop GPS attitude reference system to the breadboard stage for demonstration at the May meeting in Marburg. Possible RF interference from the spacecraft transmitters should be investigated. Possibility of student project involving APL should be pursued. Dick Daniels to assist.
2. McGwier to provide information on antenna configuration of GPS satellites.
3. King to report on test results for the GPS receiver being investigated at OSC.
4. Smith to investigate the availability of the Weber CCD fisheye camera.
5. King and Hardman to investigate the "wineglass" gyroscope technique.
6. All to be prepared for comprehensive reports and demonstrations at the May Marburg meeting, at which time decisions will be made as to what systems will be baselined for the spacecraft.

Development Facilities and Resources:
Jay Smith, Jan King

Weber State University:

Jay Smith reported to the group that a high level decision had been made at Weber State University to make a major

Dick Daniels, W4PUJ and Karl Meinzer, DJ4ZC, wonder how to get a work in edgewise as Dick Jansson, WD4FAB, belabors a point. OH7JP, Photo commitment of university resources in support of the Phase 3D development. This included the full time of two faculty members in the manufacturing area and Bob Twiggs would devote half time to the project. Ralph Butler, in attendance at the meeting, would be a full time staff member. The evening program support would be expanded and some support would be made available during the summer quarter. Machining and computing resources would be made available and a 2000 sq ft area dedicated to the project was being remodeled at university expense. This news was met with an enthusiastic response from the group.

AMSAT Mexico Support:

King said that David Liberman of AMSAT Mexico had asked him to inform the group that he had the capability to do small to medium machining tasks and would be happy to support the Phase 3D project.

Program Planning and Scheduling: Dick Jansson

Jansson distributed the first cut at a project development schedule pointing out that it was a preliminary plan that needed input from all those with responsibility for development tasks. He asked for each task leader to review and update both the work breakdown structure and the time lines then return a marked up copy to him.

Project Funding and Governing Structure: Karl Meinzer

The last subject of discussion was a survey of currently available funding for the project and amounts that the participating major groups anticipated being able to provide. He outlined the funding that AMSAT-DL had in hand or committed from the DARC and the German Science Ministry. He said that at his request DARC had asked JARL in Japan to commit to a contribution of $1 million, but that no response had been received as yet. Doug Loughmiller reported that ARRL had committed to significant funding toward the launch costs and estimated that $50 to $100 thousand could be raised from the AMSAT-NA membership. Additional major funding was being sought from U.S. foundations. Meinzer said that ESA's current position was that the launch costs to AMSAT would be one million accounting units, or about $1.5 million. This amount was still subject to negotiation and that he would continue to try to reduce the launch costs. He continued that up to $500 thousand might be required by ESA within a year and that AMSAT-DL could provide one half of this.

The proposal originally made by Meinzer at the May Marburg meeting of the need for an oversight board was further explored. The purpose of such a board was presented as primarily a mechanism for organizations providing major funding support some visibility as to how their funds were being used. At the end of the discussion, there was a consensus that some kind of oversight mechanism would be acceptable as long as it was clearly understood that direct management of the project was in the hands of the volunteers who were committing their time and talents to carrying it out.

Concluding Actions:

The Orlando meeting was concluded with a review of the action items assigned during the three days of discussion and a commitment to show progress by the next meeting in Marburg in May 1992. Recognition and an expression of appreciation was given by all present to the individuals who had planned and supported the Orlando meeting. The meeting was then adjourned.

Attendees:

Jon Bloom, KE3Z, ARRL
Ralph Butler, Weber State University
Joseph Capitano,
  Applied Solar Energy Corp.
Tom Clark, W3IWI, AMSAT-NA
Jack Colson, W3TMZ,
  Applied Physics Laboratory
Dick Daniels, W4PUJ, AMSAT-NA
Lee Edwards, N3KHO,
  Applied Physics Laboratory
Peter Guelzow, DB2OS, AMSAT-DL
Werner Haas, DJ5KQ, AMSAT-DL
Dick Jansson, WD4FAB, AMSAT-NA
Jan King, W3GEY, AMSAT-NA
Doug Loughmiller, KO5I, AMSAT-NA
Bob McGwier, N4HY, AMSAT-NA
Karl Meinzer, DJ4ZC, AMSAT-DL
Konrad Mueller, AMSAT-DL
Jyri, Putkonen, OH7JP, AMSAT-Finland
Jay Smith, Weber State University
Stan Wood, WA4NFY, AMSAT-NA
Bob Woods, W5QPD, AMSAT-NA ■

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1991 AMSAT Annual Meeting and Symposium Wrap Up

By: Gene Davies, AA6NP

It was the culmination of much time and effort on the part of our volunteer committee, but it was well worth it! The 1991 AMSAT Annual Meeting and Symposium was a smashing success.

Sincerest thanks go to Steve Smith, N8DEZ, for coordinating all the audio/visual needs and running the equipment during the two days of sessions. This was no menial task as some of the sessions were concurrent; in fact, we had three sessions going simultaneously on Friday. Steve also provided the radio and other equipment used for the OSCAR station.

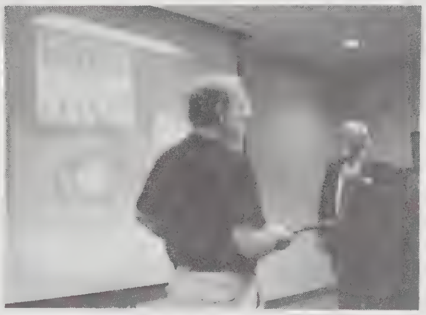
Thanks to Brian Tandrow, KR6B, for long hours spent organizing all the registration details, including banquet and JPL tour attendance. Brian also spent a great deal of time behind the registration table during the event, and helped set up the OSCAR antennas and station.

John Fail, KL7GRF, did a great job orchestrating Thursday's DX banquet. From the white knuckle caravan through Los Angeles to the choice and performance of the restaurant, everything was perfect! John was also instrumental in setting up the OSCAR station, and made many "special event" contacts via OSCAR-13.

The fellow with the loneliest job has to have been Dennis Killeby, K6IVY. While most of us were out having fun, Dennis single-handedly manned the two meter talk in station, located in a separate suite from the OSCAR station. The only mistake Dennis made was giving me the radio while he took a much needed break. I gave some poor mobile station the wrong directions and didn't realize it until he was about 15 miles away! OOPS. Dennis was also on hand to help with the OSCAR station antennas and equipment.

Thanks to Skip Reyman, W6PAJ, for setting up a fantastic tour of the Jet Propulsion Lab. Unfortunately, Skip was taken ill just before the event. Everything worked out well however, because Jan Tarsala, WB6VRN, took over for Skip during the tour. I should mention that Skip has made a full recovery and is fine.

I don't think Alan and Beth Penny, VE6LQ, knew what they were getting into when they decided to attend the symposium. Upon arrival after a very long drive, they were immediately drafted into service at the registration table. Alan and



Lou McFaddin, W5DID, and AMSAT Director and President Bill Tynan, W3XO, discussing SAREX hardware. KA1M Photo.

AMSAT Director and V.P. Engineering Jan Kin, W3GEY, explained the potential coverage of Phase 3D. Andy MacAllister, WA5ZIB Photo.

A full house at the Saturday Symposium. Drew Deskur, KA1M, Photo.

The modest mounting for the Special Events station during the Symposium. KA1M Photo.

Beth were a great help and really kept things moving. Thanks to both of them.

In addition to recognizing all our volunteers, we really have to hand it to the manufacturers and dealers who were more than generous with this year's prize donations. Despite poor economic conditions, we had over $5000.00 in prizes to give away. ICOM led the way with the donation of the grand prize, an ICOM IC-1275 all-mode 1.2 GHz transceiver. Kenwood made a superb showing with the donation of TWO handy talkies, a TH-27A 2-meter model and a TH77-A dual bander. Brooks Van Pelt of L.L. Grace Inc. made a couple lucky winners very happy with a new DSP-12 and a Kansas City Tracker. Brooks had also donated a second DSP-12 for an AMSAT fund raising effort. When it comes time to purchase a new piece of gear, I hope we all remember these most generous contributors.■

Dennis Wingo, KD4ETA, happily accepts the grand prize from AMSAT Chairman of the Board Doug Loughmiller, KO5I. Thanks to ICOM for the generous donation. John Gibson, AA6NL Photo.

Steve Smith, N8DEZ, looks quite pleased to be the recipient of a Kenwood TH77A Dual Band HT. AA5NL Photo.

Kenwood also donated the TH-27 A HT pictured here with its new owner Scott Charles, VE7FYC. Thanks to Kenwood for the valuable prizes. AA6NL Photo.

The DSP-12 shown here was one of the 3 prizes donated by Brooks Van Pelt for L.L. Grace Inc. Dennis Killeby, K6IVY, was glad to take it off Doug's hands. L.L. Grace donated two of these units as well as a popular Kanas city Tracker. AA6NL Photo.

The Second Pass

Notes from the Editor
Drew Deskur, KA1M

It was brought to my attention that the photo on the cover of the November/December issue was printed backwards. For those wishing to view the image in its proper orientation - simply hold the issue up to a mirror. You will see the images on the left of the Persian Gulf - as advertised.

Also from the November/December issue, the author of one of the shareware packages mentioned in the UO-22 article, IMPROCES© has indicated that his new address is : John Wagner, 6161 El Cajon Blvd, Suite B-246, San Diego, CA 92115.

The November/December issue was late in getting to you. We changed printers starting with that issue and along with getting them up to speed with our requirements, we also had to file for a new mailing permit. Then add in the normal holiday crunch at the U.S. Postal Service and you get a sense for why the issue arrived later than we preferred. I feel that *The AMSAT Journal* is now back on schedule and you will be pleased with the quality of the material as well as how it is printed. In addition, the quick turnaround time of the new printer allows us to print *fresh* Satellite Orbital Elements. I hope that the new format will be easier to read and use.

This marks my first full year of editing *The AMSAT Journal*. Interestingly, I have not received much in the way of feedback from AMSAT Members about whether or not this publication is meeting their expectations. I am willing to listen to your comments on what works - or what doesn't. Do you find the new Keps format helpful? Help me mold *The AMSAT Journal* into a publication which does its best to inform you. My address can be found on page 3. And keep those articles and Tech Tips coming.■

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Decoding RS-12/13 Telemetry

By: Keith Bergland, WB5ZDP

Why Satellite Telemetry?

The only way that we here on Earth can know the conditions in and around a satellite is if the satellite tells us. Once the bird is in orbit it's there for life and is quite impossible to get to. What this boils down to is that we have to listen very carefully to what the satellite is telling us. By knowing and analyzing things like temperatures, battery voltages, current drains, and charging rates, the spacecraft controllers can get a complete picture on the health of the bird. If they see anything abnormal in the telemetry, they can take corrective action to head off any potential problems. In the long run, this will maximize the life and usefulness of the OSCAR spacecraft to Radio Amateurs everywhere.

A Bit of History

Since the beginning, all satellites have had some form of onboard telemetry. In the early days of spaceflight, design engineers were very concerned with the temperature extremes that would be encountered in space. In 1961, OSCAR-1 had a primitive

TABLE 1.
RS-12 RAW TELEMETRY FRAMES

05 DEC 91 RS-12 IID81 INKOO IAK27 IMK46 NIG46 NND00 NAD00 NMG00 AIG36 AND28 AAD28 AMG35 MIK00 MND46 MAG00 MMD00 RS12	**09 DEC 91** RS-12 IID81 INO00 IAK33 IMK46 NID45 NNG00 NAD00 NMD00 AIG37 AND28 AAD43 AMD36 MIK00 MND46 MAG00 MMG00 RS12
06 DEC 91 RS-12 IID81 INKOO IAK28 IMK46 NID46 NND00 NAD00 NMD00 AID36 AND28 AAD43 AMD35 MIK00 MND46 MAD00 MMD00 RS12	**11 DEC 91** RS-12 IID81 INK00 IAK19 IMU46 NID45 NND00 NAD00 NMD00 AID37 AND29 AAD42 AMG36 MIK00 MND46 MAG00 MMD00 RS12
08 DEC 91 RS-12 IID81 INOOO IAK20 IMK46 NID45 NND00 NAD00 NMD00 AIG36 AND28 AAD43 AMD35 MI000 MND46 MAD00 MMD00 RS12	**12 DEC 91** RS-12 IID81 INK00 IAK25 IMK46 NID46 NND00 NAD00 NMD00 AIG34 AND28 AAD41 AMD35 MIO00 MND46 MAD00 MMD00 RS12

TABLE 2
RS-12/13 TELEMETRY DECODING DEFINITIONS

CHANNEL NUMBER					
1.	IIS	IID	IIR	IIG	TLM Data source sampling period 90 minutes.
	IIU	IIK	IIW	IIO	.... 10 minutes.
				##	Power supply voltage over sampling period where V=N/4 volts.
2.	INS	IND	INR	ING	2 Meter receiver with -20 dB attenuator in.
	INU	INK	INW	INO	.... 0 dB attenuator in.
				##	N/10=W (in watts)- output power on 2M Xmitter.
3.	IAS	IAD	IAR	IAG	15 Meter receiver with -10 dB attenuator in.
	IAU	IAK	IAW	IAO	.... 0 dB attenuator in.
				##	N/10=w (in watts)- output power of 10 Xmitter.
4.	IMS	IMD	IMR	IMG	15 Meter uplink is "OFF"
	IMU	IMK	IMW	IMO	15 Meter uplink is "ON"
				##	N/5=V (in volts)- 15 Meter receiver AGS voltage.
5.	NIS	NID	NIR	NIG	2 Meter uplink is "OFF"
	NIU	NIK	NIW	NIO	2 Meter uplink is "ON"
				##	N/5=V (in volts)- 2 Meter receiver AGS voltage.
6.	NNS	NND	NNR	NNG	Special Command station channel is off
	NNU	NNK	NNW	NNO	.... on
				##	N/5=V (in volts)- Special Command Stn. RX AGS.
7.	NAS	NAD	NAR	NAG	Output power of 10 Meter beacon 1 is Maximum.
	NAU	NAK	NAW	NAO	...............................Minimum.
				##	N/3 - Service command parameter.
8.	NMS	NMD	NMR	NMG	Output power of 10 Meter beacon 2 is Maximum.
	NMU	NMK	NMW	NMO	.... Minimum.
				##	N/3 - Service command parameter.
9.	AIS	AID	AIR	AIG	Status of 1st Memory board = OFF.
	AIU	AIK	AIW	AIO	.... = ON.
				##	N-10 = Degrees C 10 Meter transmitter temp.
10.	ANS	AND	ANR	ANG	Status of 2nd Memory board = OFF.
	AIU	AIK	AIW	AIO	.... = ON.
				##	N-10 = Degrees C 2 Meter transmitter temp.
11.	AAS	AAD	AAR	AAG	There is information in 1st Memory.
	AAU	AAK	AAW	AAO	There is not any information in 1st Memory.
				##	N-10 = Degrees C 20 volt power supply temp.
12.	AMS	AMD	AMR	AMG	There is information in 2nd Memory.
	AMU	AMK	AMW	AMO	There is not any information in 2nd Memory.
				##	N-10 = Degrees C 9 volt power supply temp.
13.	MIS	MID	MIR	MIG	Output from memory via beacon 2.
	MIU	MIK	MIW	MIO	..................via beacon 1.
				##	N/5 = volts Control parameter backup 9V P.S.
14.	MNS	MND	MNR	MNG	Attenuator of 15 meter ROBOT receiver = -10 dB.
	MNU	MNK	MNW	MNO	.... = 0 dB.
				##	N/5 = V (in Volts) Voltage of 15M ROBOT RX
15.	MAS	MAD	MAR	MAG	Attenuator of 2 meter ROBOT receiver = -10 dB.
	MNU	MNK	MNW	MNO	.... = 0 dB.
				##	N/5 = V (in Volts) Voltage of 2M ROBOT RX
16.	MMS	MMD	MMR	MMG	Output power of special command channel is Max.
	MMU	MMK	MMW	MMO	.... Min.
				##	N= 00 there are less than 32 QSO's in ROBOT Log. N= 80-99 there are one or more pages of QSO's.

(but effective) onboard telemetry system. To measure the spacecraft temperature, it had a 145 MHz beacon that transmitted the letters "HI" in CW over and over again. The onboard transmitter incorporated thermistors that would vary the code speed as a function of temperature. By counting the number of "HI"s sent per minute, Amateur Radio operators (or anybody with a 2M receiver) could use a simple formula to calculate the actual spacecraft temperature.

As subsequent OSCAR's became more complex, the number of onboard systems needing to be monitored grew. In 1972 OSCAR-6 was launched with an onboard telemetry package that monitored 24 different parameters. The status of each system was relayed to the ground by a CW beacon. OSCAR-7 had a CW telemetry beacon similar to OSCAR-6's; however, in addition, there was a RTTY beacon that monitored 36 different channels of data! AMSAT's newest Phase III satellite, OSCAR-13, has a very sophisticated telemetry computer that monitors over 50 different data points. When not transmitting telemetry and messages in CW or RTTY, OSCAR-13 transmits 400 baud BPSK (bi-phase shift keying) giving ground stations a concise and up to the minute picture of the latest condition of all subsystems on the satellite.

RS-12/13 Telemetry

RS-12/13 is a good satellite for the beginner to start copying telemetry in that it is easy to hear and requires no special modems or software. The actual telemetry is transmitted by common 18 WPM CW and is easy to copy with even modest antennas. RS-12/13 is primarily a Mode K satellite making telemetry reception possible for anybody with an 10M HF rig or general coverage receiver.

The frequencies to listen to are 29.408 MHz if RS-12 is on, and 29.458 MHz if RS-13 is on. For most of this bird's life, RS-12 has been active. The CW is relatively easy to copy; however, it is best to tape record the information and play it back to insure accuracy.

The CW telemetry is presented in the form of three letters followed by two numbers. Each set of numbers and letters is called a Block and 16 Blocks make a Frame. A sample of several frames of telemetry taken over many days is shown in Table 1. Decoding a frame of data provides a "snap-shot" in time of the conditions on board the satellite. Decoding several frames of data over many days or weeks provides a dynamic, ongoing picture of the life of the satellite.

If several frames of data are decoded over a long period of time several interesting patterns result. Voltages and temperatures will fluctuate depending on whether the satellite is observed during the day or night. Current drains and receiver attenuation will fluctuate depending on how many users are on the transponders and which transponders are on. I have observed that the receive attenuators are more likely to be switched in on the weekend. I would be curious to know what patterns you observe.

Decoding RS-12/13 telemetry is really quite simple. After recording a frame of data, the decoding process can begin by referring to Table 2. The letters tell which subsystem is being measured and the numbers represent the value for that parameter. As an example, look at block 3 of the 12 DEC 91 data presented in Table 1. The block reads "IAK25". The "IAK" indicates that the 15 Meter Receivers 10 dB receive attenuator is "out" (not in line) and the 33 indicates that the 10M power output is 2.5 Watts (25 / 10 = 2.5). The ninth block of data reads "AIG34". Again, referring to Table 2, the AIG indicates that the first memory board is "OFF" and the 34 says that the 10M transmitter temperature is 24 degrees Celsius (34−10 = 24). An example of a complete Frame of decoded RS-12 telemetry can found in Table 3.

So What Now?

Decoding RS-12/13 telemetry may seem like a tool for ground stations and an exercise for the serious satellite enthusiast, however, this is not true. For those who only make a few contacts through the satellite now and then a quick look at the telemetry will reveal much information. For example, a glance at Blocks 4 and 5 will tell you which radio to use on the uplink. In the case of the 12 DEC 91 data in Table 2. the "IMK" indicates that the 15M receiver if "ON" and the "NID" indicates that the 2M receiver is "OFF". What this means is that the bird must be in Mode K and not in Mode A or T. This hypothesis is further confirmed by noting that in Block 2, there

(continued on page 23)

TABLE 3
RAW AND DECODED RS-12 TELEMETRY

RS-12 Telemetry as copied 12 DEC 91: RS12

IID81	INK00	IAK25	IMK46
NID46	NND00	NAD00	NMD00
AIG34	AND28	AAD41	AMD35
MIO00	MND46	MAD00	MMD00

RS12

RS-12 Telemetry after decoding:

1. TLM Data source sampling period 90 minutes.
   Power supply voltage over sampling period = 20.25 volts.
2. Meter receiver has 0 dB attenuator in.
   Output power on 2M transmitter = 0 Watts.
3. 15 Meter receiver has 0 dB attenuator in.
   Output power of 10 transmitter is 2.5 Watts.
4. 15 Meter uplink is "ON"
   15 Meter receiver AGS voltage = 9.2 Volts.
5. 2 Meter uplink is "OFF"
   2 Meter receiver AGS voltage = 9.2 Volts.
6. Special Command station channel is off
   Special Command Stn. RX AGS = 0 Volts.
7. Output power of 10 Meter beacon 1 is Maximum.
   Service command parameter = 0.
8. Output power of 10 Meter beacon 2 is Maximum.
   Service command parameter = 0.
9. Status of 1st Memory board = OFF.
   10 Meter transmitter temperature = 24 Degrees C.
10. Status of 2nd Memory board = OFF.
    2 Meter transmitter temperature = 18 Degrees C.
11. There is information in 1st Memory.
    20 volt power supply temperature = 31 Degrees C.
12. There is information in 2nd Memory.
    9 volt power supply temperature = 25 Degrees C.
13. Output from memory via beacon 1.
    Control parameter backup 9V P.S. = 0 Volts
14. Attenuator of 15 meter ROBOT receiver = -10 dB.
    Voltage of 15M ROBOT RX = 9.2 Volts
15. Attenuator of 2 meter ROBOT receiver = -10 dB.
    Voltage of 2M ROBOT RX = 0 Volts.
16. Output power of special command channel is Max.
    There are less than 32 QSO's in ROBOT Log.

DOVE Chronology

[DOVE Returns to 2 Meters!! Just prior to press time, Bob was able to return DOVE's 2 meter transmitter to active service. Although this is just another milestone along the way to getting DOVE talking, it none the less is tangible evidence that progress on DOVE is being made. The following article is sort of a Developer's Journal of DOVE's life]

By: Harold Price, NK6K
Bob McGwier, N4HY

The intent for the Microsats is that they would be nearly identical to each other as far as operating characteristics are concerned. This led to the desire for one standard operating system for the Microsats, and also for the UoSAT-3 and UoSAT-4 spacecraft. This operating system, along with AX25 drivers, file servers, and other applications, is large and feature-rich, and has been one of the enablers for the wonderful, fully automated, file and directory download broadcast facility now in use on UO-14 and soon to be commissioned on AO-16 and LO-19. It unfortunately also takes a large number of interactions with the spacecraft to load.

The bootloader for the Microsats was written assuming full duplex capability. Full duplex (simultaneous transmit and receive) is available on all Microsats except DOVE with its failed S-Band transmitter. One of the design drivers for the Microsats was low cost, small size, limited redundancy.

DOVE doesn't have a redundant set of receivers on a frequency other than in the same band as the main transmit band. It has a redundant transmitter in another band, but it has failed and is 99% useless. It was decided early in the Microsat program that a receiver that was not in-band with the main 2-meter DOVE transmitter would not be provided.

Perhaps we should have reported the DOVE mission as failed as soon as the condition of the S Band transmitter became evident. Instead, we said "this is no big deal", and embarked on what turned out to be a rolling list of setbacks.

Based on memory, here is a chronology of those failures:

1) Problems in fabrication of the spacecraft computers prevents testing with the spacecraft until two months before launch. All available test time goes into hardware testing, none into software testing.

2) This leads to problems in the boot ROM which prevent testing of the loading sequence until hours before they must be soldered in.

3) We discover that no amount of power will get into the DOVE receiver when the 2 meter transmitter is set anything but the 30mw level during final integration at Kourou, and even then the power required from 700km is not likely to be generated. Up until this time, the software group had been working under the assumption that, as with the UO-11 DCE, an OSCAR-10 class station would be able to work with DOVE full duplex on two meters. No matter though, we'd just have to equip a station with S-Band receive capability.

4) Since the integration at Kourou is almost the first time the software group gets a chance to test the software and hardware together, the power management and spacecraft control software is rudimentary at best.

5) Post-launch, most of the time is spent checking out hardware and fixing the power management routines. The highest priority on the applications side is assigned to WEBERSAT, as there is some question as to how long the camera's moving parts will last (this turned out not to be a problem).

6) Due to the tight schedule and the assignment of all software resources to hardware check-out and integration support, real application development does not begin until two months after launch. Most of the application development is done at Surrey by Jeff Ward, G0/K8KA, with support and operating system work done by two developers in the US. A third continues to work on refining the command and control software.

7) During this time, DOVE, which had been running the simple power control and telemetry program that was loaded prelaunch, fails with the two meter transmitter on. It had been cycling 2.5 minutes on, .5 minutes off to allow commanding. Fortunately, it failed in a state where the power load was higher than the power received by solar arrays. In dark, the receivers and transmitters shut down due to low voltage, but the computer did not. In light, the transmitters would come back on. There was a small window between the transmitter failing and the receiver failing where the "Big Gun" 2 meter moonbounce array at W5UN, along with the help of its operator, Dave Blaschke, was able to get the reset command through.

There followed several weeks of head scratching and the addition of several new DOVE-specific safeguards in the software. Recall that the software was written assuming the main receiver could always hear the reset command. Since this backup was always available, draconian failsafes were not added to the software. These were added in the summer of 1990.

8) During the attempts to reload DOVE, it became clear that the S-Band modulator had failed. Data was present, but without sufficient modulation to decode. Several weeks were lost in an attempt to use DSP to decode the data, but there was so little modulation that realtime decoding with available amateur-level equipment was not possible. N4HY could decode recorded data with some amount of Cray time, but this was not a practical solution.

9) Next, we had to come up with a version of the bootloader which would send ACK signals in a way that one could hear, by ear, the small bobble of noise that comes out the S-band transmitter when data is sent. We then had to modify the ground station loader to allow a human operator to tell it via the keyboard when an ACK had occurred. This took some time to build and qualify, the work was done by N4HY with help from Hugh Pett.

10) Each time DOVE was reloaded by ear, there were several problems:

a) Not all of a pass could be copied by the available ground stations.

b) Fast doppler shift, fading, noise, antenna offpointing, kids, etc., all combined to make it very hard to hear the ACKs. One bobble that was not an ACK, but was interpreted as such, would cause a bad load.

c) The longer it takes to get a load in, the more chance that a particle would cause a bit to flip, a "Single Event Upset (SEU)". This could also cause the program to crash once is was started. The bootloader does not "wash" memory, by design.

We were still, at this time, trying to load the same base software as had been loaded on the other spacecraft. This software was running fine, was accumulating a large number of orbit hours in operation, and was what we wanted to end up with on DOVE. It was large (requiring about 40k to be loaded by ear), so the chance for a misload was large.

11) The new draconian software checks uncovered a problem in commanding the DOVE/S-BAND module. After the scare with locking the 2-meter transmitter on, we added code to go to the ROM bootloader

when we couldn't confirm successful operation of a command on the internal command bus (the AART). This required several reloads to determine the problem, since there was no way to download the failure codes via the S-BAND transmitter, and the ROM bootloader could not toggle the 2-meter transmitter on or off.

12) We finally got DOVE back on two meters. One of the new draconian software checks was the addition of a "ground not heard" timer. Someone on the ground built up an automated station for the sole purpose of sending periodic "keep running" messages.

13) Emphasis now shifted to UO-14/AO-16/LO-19. We wanted to get the BBS software up and running on all three. Moreover, Bob and Harold wanted to get the software and operating procedures stabilized enough so that a new group of spacecraft operators could be brought in. Remember, there had been no time before launch to even finalize and test the software, let alone train operators. Over a period of a few months, this work was completed.

14) There then followed a long period of stagnation on DOVE. Part of this was caused by Bob's work trips, illnesses, vacations, etc., as the coordinated efforts of many people were required to take the next step. Over this time, a new S-Band ground station was built so that Bob did not have to listen over a long distance phone line to a remote big ear station to hear the ACKs to do the manual loading. DOVE work was again delayed in part because of work on the other Microsats, as follow-on work was done to the BBS software. Part was caused by the sheer drudgery of trying to deal with the various failed parts of the DOVE hardware. The Desert Shield/Desert Storm events also created a load, as a few of the players involved in DOVE had real jobs that were impacted by this, either in some direct involvement, or in getting some rush jobs at work to make modifications to software for equipment being rushed into service.

15) Finally, all the people and parts fell into place so that the next round of DOVE work could be done. This involved modifying the 2-meter software driver to work in a push-to-talk mode instead of the full duplex mode used by the other spacecraft, while at the same time adding as many safeguards as was reasonable to protect against another 2-meter lockup. This was done, and DOVE was back on 2-meters in such a way that application software would be loaded under machine control.

16) Finally, in the fall of 1991, several tests were done, and the spacecraft was reset prior to reloading it with "production" software. The outside world stepped in again, and the events which led up to the breakup of the USSR took all hobby time away from the designer of the DOVE talker hardware/software.

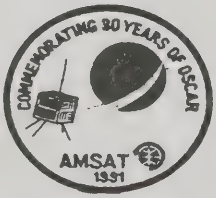
17) Over this past Christmas holiday, Bob has been trying to reload DOVE with the Push-to-Talk loader so we can load the speech application. This has failed three times in a row.

A few more tries were attempted to load the base Microsat operating system by ear, with negative results. Then, a new intermediate mini-loader was developed that will do the job with PTT using the 2-meter transmitter. It will also wash memory. With 20-20 hindsight, we should have started that when it was clear that DOVE would never run full duplex, but we didn't.

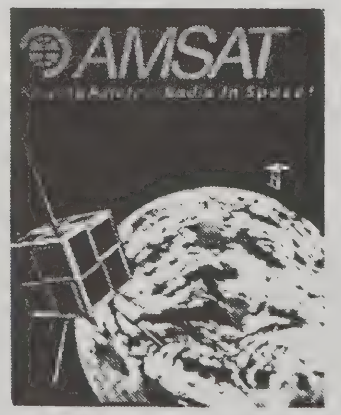
We've always been leery of doing this, since there is no ground-based mock-up of a Microsat, just two partial CPUs. Since all of the existing software depends on the features of the 40k operating system/control application (aart driver/hdlc driver/watchdog services, etc.), a lot of new code would have to be commissioned, designed, implemented, and (the kicker) tested without a real spacecraft to test on. Even a small error could result in a lock-on of the 2-meter transmitter, if this occurs with a positive power budget, not only will we have lost DOVE, but we'll have a stuck-on signal in the 2-meter band for years to come.

Believe us, we HAVE been working at getting DOVE going. Wish us luck. ■

A Beginners Guide to OSCAR 13, by Keith Berglund, WB5ZDP, is a step-by-step guide to getting started on OSCAR 13. $7 in the U.S., $8 in Canada and Mexico, $10 elsewhere. Call AMSAT Hq., 301-589-6062 to order.



AMSAT Patch: $5.00 U.S.



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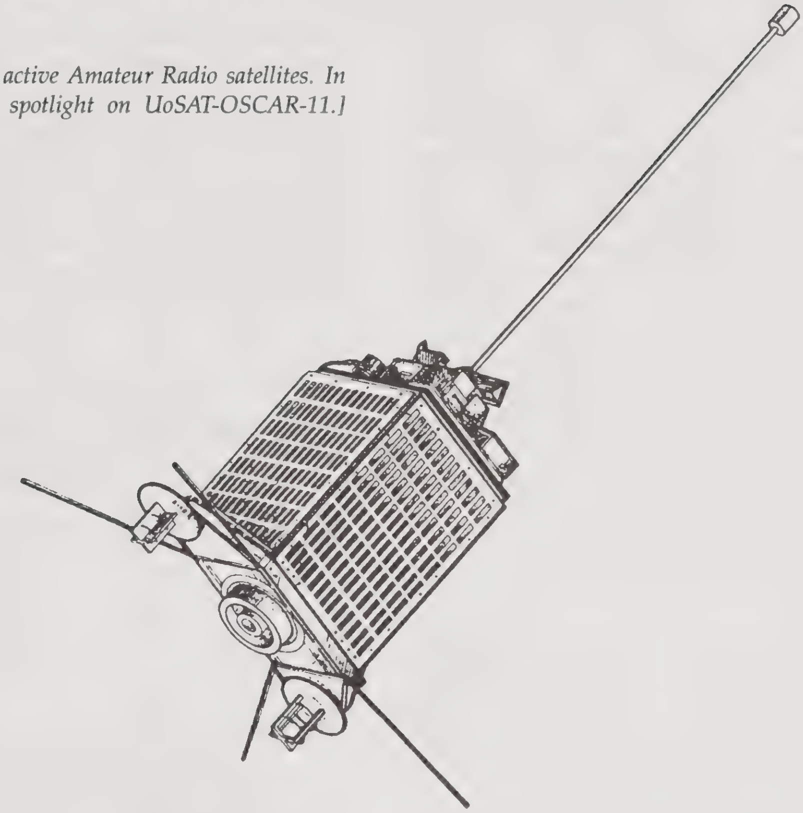
AMSAT

Spotlight On: UoSAT-OSCAR-11

[This article is the first in a series of surveys of currently active Amateur Radio satellites. In this issue of The AMSAT Journal, KD2BD shines the spotlight on UoSAT-OSCAR-11.]

By: John A. Magliacane, KD2BD
1320 Willow Drive
Sea Girt, NJ 08750



SPECS:

Name:	UO-11 aka UoSAT-2
Object #	14781
Launch:	1 March 1984
Period:	99 Minutes
Increment:	24.6° west per orbit
Orbit:	Polar LEO (Low Earth Orbit)
Altitude:	680 km (423 miles) average
Dimensions:	58.5 cm (23 in) 35.5 cm (14 in) 35.5 cm (14 in)
Weight:	60 kg (132 lbs)
Telemetry:	1200 bps FM AFSK
Downlink:	145.825 MHz (most common) 435.025 MHz 2401.5 MHz

Imagine... It's March, 1988. You're part of a skiing expedition across the North Pole. Your team's position is calculated through a COSPAS network and relayed to the University of Surrey where OSCAR-11's Digitalker is programmed to reflect your daily positions. Finding your location is as easy as turning on your 2-meter handheld! Daily updates carried on OSCAR-11 help you and your team navigate despite the brutal Arctic conditions.

A massive solar flare disrupts all HF skywave propagation. WWV can't be heard. As OSCAR-11 comes into range, you capture whole orbit telemetry data from the spacecraft and plot the information graphically on your computer. Radiation counts over the poles have increased dramatically. Space dust counts have skyrocketted along with radiation induced RAM errors. OSCAR-11 keeps you abreast of the progress of the event as it circles the globe gathering more important information.

A packet message you've received half a world away demands a rapid reply. Quickly, you fire off a response and direct it through your closest OSCAR-11 DCE Gateway station. Your mail message is relayed through OSCAR-11 and arrives at its destination within hours, without the use of HF gateways. OSCAR-11 provides that important communications link.

You are called away on business to a place where no VHF packet activity exists. You pack a 2-meter handheld, a small antenna, and a UoSAT demodulator along with your laptop. Weekly news bulletins received through OSCAR-11 keep you informed on the latest happenings in the Amateur Satellite program regardless of where you are in the world.

Spacecraft History

UoSAT-OSCAR-11 is the second in a series of Amateur satellites designed and built by a team of engineers at the University of Surrey in Guildford, Surrey, England. UoSAT-OSCAR-11 was designed to compliment UoSAT-OSCAR-9, which carried experiments supporting space engineering, science, education, and Amateur Radio propagation studies.

UoSAT-OSCAR-11 was launched from the Western Test Range at Vandenberg Air Base, in Lompoc, California along with LANDSAT-5 on a Delta 3920 rocket on March 1, 1984. OSCAR-11 is the most rapidly designed OSCAR, going from inception to launch in only five months! OSCAR-11 is also the first amateur satellite to carry a digital communications package into Earth orbit, and the first to be controlled by a CPU running software written in the high-level programming language "Forth".

Unlike most OSCAR satellites, UoSAT-OSCAR-11 does not contain real-time communications transponders. Instead, its beacons downlink a wealth of information concerning the "near-Earth" environment in a variety of formats. There's a "Digitalker" speech synthesizer on-board capable of transmitting telemetry data and pre-programmed messages in plain English using either "American" or "English" accents, a charged coupled device (CCD) Earth imaging camera capable of providing 384×256 pixel resolution digitized to a 7 bit gray scale, space dust impact detectors, Geiger counters, and a Digital Communications Experiment (DCE) for handling electronic mail on a store-and-forward basis between groundstations on Earth.

UoSAT-OSCAR-11 carries three beacon transmitters that are easily heard using simple groundstation equipment. The VHF beacon carries Audio Frequency Shift Keying (AFSK) at 1200 baud plus analog voice messages all on a single narrow-band FM carrier frequency of 145.826 MHz. The UHF beacon is capable of producing either AFSK-FM or high-speed PSK on a carrier frequency of 435.025 MHz. This beacon is most often used to downlink information from the Digital Store and Readout (DSR) Experiment at 4800 baud, which includes CCD Earth image data, results from the Particle Wave Experiment, and engineering data from the RCA COSMAC 1802 CPU. The SHF beacon is the least used, but can sometimes be heard transmitting FM and

PSK signals on a carrier frequency of 2401.5 MHz. Antenna polarization for all three beacon transmitters is left-hand circular (LHCP).

Telemetry and news bulletins transmitted by OSCAR-11 are sent using phase synchronous audio frequency shift keying on a narrow-band FM carrier with AFSK tones of 1200 Hz (logic "0") and 2400 Hz (logic "1") and a data rate of 1200 bps. This modulation format permits synchronous AFSK demodulation and post detection correlation decoding, making weak signal detection possible with a minimum of data errors. Most UoSAT demodulators, however, are simple PLL designs that work well under noise-free reception conditions.

The current schedule of OSCAR-11 operations is as follows:

145.826 MHz:

From 00:00 Thursday to 23:59 Tuesday (UTC)

ASCII Telemetry	45 seconds
ASCII Status Message	15 seconds
Binary Telemetry	30 seconds
ASCII Bulletin	90 seconds
Binary SEU Dump	30 seconds
Binary Engineering Frame	30 seconds
ASCII WOD	180 seconds
Binary WOD	120 seconds
Binary Telemetry	45 seconds
DCE Titles	60 seconds
TOTAL	645 seconds

From 00:00 to 13:59 Wednesday (UTC)

Binary Telemetry	45 seconds
ASCII Telemetry	150 seconds
ASCII Status Message	15 seconds
TOTAL	210 seconds

From 14:00 to 23:59 Wednesday (UTC)

ASCII WOD	120 seconds
ASCII Status Message	15 seconds
TOTAL	135 seconds

435.025 MHz:

From 00:00 to 12:00 Sunday (UTC):
4800 Baud DSR Data
From 06:00 to 14:00 Wednesday (UTC):
4800 Baud DSR Data

Because of power budget constraints, the 435.025 MHz transmitter is off at all other times.

This schedule is often interrupted during one AM (UTC) pass on weekdays (except Wednesday) for routine operations from the UoS Groundstation. During these operations, the downlink will be on 435.025 MHz 1200 baud and the VHF beacon will be off.

UoSAT-OSCAR-11 is in a low-altitude, circular, sun-synchronous Earth orbit. It can be received anywhere on the planet, several times a day. AMSAT-NA, Project OSCAR, and AMSAT-UK all carry OSCAR-11 telemetry decoding and analysis software, and there's more to come! OSCAR-11 telemetry analysis activities are very fascinating and offer a low-cost approach to Amateur satelliting. Give it a try! OSCAR-11 reception reports should be directed to the spacecraft controllers as follows:

UoSAT Spacecraft Engineering
Research Unit
Department of Electrical Engineering
University of Surrey
Guildford, Surrey GU2 5XH
England

Next time, we'll shine the spotlight on Amateur Radio's most powerful communications satellite: OSCAR-13! ■

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BBS Information Sources

[As you know, current information is a vital necessity for getting the most out of satellite operations. Knowing where to find this information, therefore, becomes very important.

There are several landline BBSs available across the nation that specialize in satellite information. Over the next several issues of the AMSAT JOURNAL, we hope to review several of these BBSs in order to acquaint you with the information possibilities available to the satellite operator.

If you would like to submit a write-up for your satellite-oriented BBS, please contact Doug Howard, KG5OA, at (817) 292-6440. Compuserve 70233,3517 Enjoy!]

Dallas Remote Imaging Group BBS Public Line (214)394-7438

Satellite Tracking, Satellite Imagery, Digital Image Processing, Digital Signal Processing, and Soviet Space Programs

By: Jeff Wallach, Ph.D., N5ITU
Chairman, DRIG

The Dallas Remote Imaging Group is pleased to announce some major upgrades to the DRIG BBS. The DRIG BBS has been in operation since 1984, and has served the membership as the leading source of information on satellite tracking, weather satellite and remote sensing imagery, digital image processing, digital signal processing, and all aspects of the Soviet, Chinese, and American Space Programs.

The DRIG BBS at public number (214)394-7438 has been expanded with the following capabilities:

- Three new telephone lines (automatically rotated)
- Local Area Networking with new 80486 Server
- Over 2 Gigabytes of CD-ROM with NASA Voyager Images and NOAA AVHRR imagery
- ROSEMAIL and automatic Conferencing
- PCBoard 14.5A BBS Application software
- On-line Tutorials
- Soon to be added INTERNET access and News Groups Mail
- US Robotics 38.4 K Dual Standard Modems on all Ports (1/92)
- Thousands of ham radio and Satellite telemetry programs
- EMAIL to thousands of satellite tracking stations world-wide

The DRIG BBS operates 4 personal computers as front end communication controllers, all linked with a 10 Mbps Ethernet LAN. Professional Members (supporting) may dial a PRIVATE NODE telephone line and be automatically routed to any of the other three ports if the main line is busy. A CHAT function is available to talk, ONLINE, with any of the other users logged on to the other ports.

The DRIG BBS has as its primary mission the support of the membership interest in new satellite launches, satellite telemetry and imagery analysis, the development and distribution of new satellite tracking programs, updated image processing and display applications, electronic mail from a world-wide network in place to track new satellites, satellite frequencies, and orbital determinations. There are over 4000 members world-wide included in the membership roles on DRIG.

DRIG has several thousand satellite images in GIF and RAW 8-bit binary format for the membership to utilize. Image processing and display programs are available on the system to view and manipulate these images. Members worldwide upload these images as they are captured from Soviet, Chinese, and American civilian and military satellites. Many members have automated tracking and image capture stations that allow dowlinking of images in automatic mode.

DRIG also supports the AMSAT membership by providing NORAD satellite keplerian elements and AMSAT bulletins updated on a weekly basis. The DRIG BBS contains imagery from AMSAT-UOSAT satellites as well as civilian, military, and other remote sensing satellites. AMSAT members may browse the BULLETIN section of the DRIG BBS for the latest update on the keplerian elements and AMSAT news. The following Bulletins contain the keplerian elements:

- BULLET90 - NASA 2 line elements
- BULLET91 - AMSAT format elements
- BULLET92 - Weather Satellite elements
- BULLET7 - AMSAT News Service bulletins

Professional (supporting) members may dial the new PRIVATE telephone line at (214)492-7573.

Associate members (non-supporting) dialing this number will be presented with a message asking them to dial back on the PUBLIC line, which is: (214)394-7438.

New users dialing into the DRIG BBS will be asked to complete a REGISTER function. This will generate a database entry and will also allow a postcard mailing to be made to the new user. Users that would like to become a Professional member of the DRIG BBS are asked to make a $30.00 per year (365 day) donation to help support the expanding functions and capabilities of the system. MASTERCARD/VISA will be accepted in early January, 1992. Users may submit a check to the address listed below.

New members may send a 9 x 12 stamped envelope (6 first class stamps, please) to the DRIG office for a membership package, and information on satellite tracking, satellite frequencies, and digital image processing in general. A three page primer on weather satellite imagery will also be included. This material is free for the asking. We only ask that the postage be covered in the request.

The DRIG office may be contacted at the following numbers:

FAX: (214)492-7747
BBS: (214)394-7438
VOICE Mail: (214)394-7325
Internet: jw%drig@kf5iw.lonestar.org
or: kf5iw.lonestar.org!drig!jw
Compuserve: 76326,2447
PACKET: N5ITU@W5TOO

Dallas Remote Imaging Group
P.O. BOX 117088
Carrollton, Texas
75011-7088

The members of DRIG encourage you to participate in discussions on satellite tracking, satellite imagery, and the American and Soviet space programs in general. ■

JOHNSON SPACE CENTER
W5RRR
AMATEUR RADIO CLUB

Which AMSAT Tracking Program Should I Get?

By: G. Gould Smith, WA4SXM

AMSAT-NA offers four excellent software tracking programs for the IBM type personal computer: InstantTrack, QuikTrak, and Orbits II/III. People often ask me which one I recommend. My truthful response is, "I use all of them, they each possess unique features I want to use". The key question is (as in all software selection) -- What do you want it to do? Look through the tracking software comparison table and determine which piece of software best fits the features you are interested in. Make sure that the software is compatible with your computer, monitor and video card. You may find, as I have, that each have features you would like to use. There is no reason that you can't have more than one piece of tracking software. Remember, this software is donated to AMSAT to help raise money to keep amateur satellites in orbit. You get a great value for your donation.

From talking with a number of people about the tracking software, I have found that many of the features of these great programs go unused. After demonstrating the software I often hear "I didn't know it would do that!". These features are described in the documentation accompanying the software and in InstantTrack's online Help file. But it has been my experience that after the program is up and running, the documentation is shelved and the Help file goes unused. I set about putting together an easy to read and understandable description of most useful functions of InstantTrack and QuikTrak programs. It proved too long for a magazine article (over twenty pages). These descriptions are generally written in a question and answer format. Like, " How do I select the satellites displayed at the bottom of the InstantTrak screen?". If you are interested in a copy, I will be happy to send you one for $2 to cover copying, the mailer and postage.

Here in a condensed form are acronyms, abbreviations, subfunctions and active keys used by InstantTrack and QuikTrak. The reference sheets are organized by Main Menu functions. These sheets are designed to make it easier to find and use the features of the tracking programs. I place the sheets back to back inside a plastic sheet protector and keep it near the computer for reference. If you have an older version of one of these programs, the computerized updating of the element sets feature makes upgrading worthwhile. You will be amazed at how much you can learn

	InstantTrack V1.0	**QuikTrak V4.0a**	**Orbits III V4.01**	**Orbits II V4.02**
Type of computer monitor	EGA/VGA(graphics) CGA/Mono/EGA/VGA(text)	CGA/EGA/VGA some Mono	EGA,VGA	CGA
Ram required	512k	64k EGA/VGA 512k CGA	512k	512k
DOS version	= v3.0	= v3.0	= v2.0	= v2.0
Hard disk recommended	yes	yes	no	no
Print a satellite schedule	PrtSc(1 pg)	yes	yes	yes
Satellite schedule to disk	no	yes	yes	yes
Graphics display(s)	excellent	very good	good	good
Display multiple satellite locations simultaneously	text (7)	text (14) graphics(14)	text (9) graphics(9)	text (9) graphics(9)
Station co-visibility schedule	no	yes	no	no
Print a tracking log	PrtSc(1 pg)	yes	yes	yes
Tracking log to disk	no	yes	yes	yes
Grey-line display	yes	yes	if selected	if selected
Time to AOS	yes(1 sat)	yes(14 sats)	no	no
Ease of satellite ordering	Vgood w/ITSORT	fair	good	good
View from the satellite	yes	no	no	no
Visual observation of sat calc	no	yes	no	no
Satellite schedule with duration and max elevation	no	yes	no	no
Equator crossing/apogee	no	yes	no	no
Coprocessor recommended	yes	yes	no	no
City, grid square, station observer information	yes	no	no	no
City locator	yes	yes	no	no
Daily multiple sat schedule	yes	no	no	no
Online help	yes	no	no	no
Automatic time setting	yes	external	no	no
Display realtime tracking	text & graphics	text & graphics	text & graphics	text & graphics
Automatic elements updating	yes	yes	yes	no
Rotor control	yes	yes	yes	yes
Pointing/squint angle	yes	yes	yes	yes

InstantTrack v1.0 Reference Sheet

Q key	Quit
? key	online Help
yellow text	means satellite is in view
green text	means satellite is below your horizon

Realtime Track 1 Satellite (Text Screen)

spacebar	freeze the screen
B	Bottom Display toggle
C	nearest city to subsatellite point
E	Edit/look at the satellite elements
I	XYZ Cartesian coordinates display toggle
O	Observers, display how other locations view the satellite
Q	Quit, return to main menu
R	Rotor control toggle
S	RA/Decl/TSky information toggle
T	Time - change date/time or return to realtime
W	Next satellite rise time toggle
⇐⇒	goto previous/next satellite
dR/dt	rate at which the range is changing in km/sec
R.A.	Right Ascension, astronomical coordinate
Decl.	Declination, astronomical coordinate
Tsky	is the sky noise temperature toward the satellite
Offp	Off pointing angle, squint angle
Path Loss	is the amount of signal attenuation caused by distance

Realtime Track 1 Satellite (Map Screen)

spacebar	freeze the screen
C	Cities, display dots for many of the cities in the database
E	Edit/look at the satellite elements
F	Fast forward, speed up time mode or return to realtime
O	Observers, how other locations see the satellite
P	Projection - pressing this key 1-4 times will give 1 of 4 orbital graphics 4P Cylindrical map, Mercador projection of Earth (default) 1P Orthographic globe, view from the satellite 2P Orbit view, engineering drawing of 3-D orbit 3P Sky view gives: 100 deg azim x 60 deg elev view of the sky with the satellite, horizon, 790 brightest stars, sun & moon
Q	Quit, return to main menu
R	Rotor control toggle
S	Scrolling display, toggle display center, Greenwich or subsatellite longitude
T	Time/Date change or return to realtime
U	Update the map now
W	Next satellite rise time toggle
⇐⇒	goto previous/next satellite

Satellite Position Table (Ephemeris) satellite tracking schedule

PrtSc	to print one page of schedule
ENTER	gives next page of data
⇐⇒	goto previous/next satellite
C	key toggles between Lat/Lon or city display
S	key toggles between Scroll and Page mode

Satellite Visibility Schedule

Satellite visibility graph in 20 min segments for:

(1) 20 days for 1 satellite or
(2) 1 day for up to 20 satellites by group

Update Satellite Elements

Item #3	to automatically update satellite elements from an ASCII file, sat name and number must match that in the element set
Item #6	to delete old satellites

(Update Satellite Elements continued)

Item #8 (a) to manually edit the Keplerian element set
(b) to define the schedule string for mode display
(**MAX** 6 mode changes, 1 letter/mode)

MA 000 - 003 OFF
MA 003 - 095 mode B
MA 095 - 125 mode J
MA 125 - 130 mode LS
MA 130 - 135 mode S
MA 140 - 255 mode B is encoded as:

Schedule: 000O030B095J125L130S140B

(c) to set the attitude for pointing angle calculation (integer values only)

Attitude: BLAT,BLON

(d) to set satellite diameter in meters (not currently used)

Diameter: 1.0

(e) to select the satellites for bottom display and groups

Groups: !ARL

!	selects this satellite for bottom of the screen display
A	makes this satellite part of the Amateur satellite group
R	makes this satellite part of the Russian group
L	makes this satellite part of the LEO(low earth orbit) group

(f) to define the most common beacon frequency. used by doppler, path loss & Tsky

Beacon Frq, F1: 145.812

(g) pressing the "D" key will give derived values, how old the element set is

⇐⇒	goto previous/next satellite
Q	to exit this function and get a prompt to SAVE changes

Update Station Elements

Configure your station parameters and add cities to observer list
Latitude of your QTH, + (plus) value North of the equator, use 2 decimal places
Longitude of your QTH, - (minus) value West of Greenwich, use 2 decimal places
Elevation in meters above sea level

Multiple Satellite Co-Visibility

Array showing which satellites can see one another, can be displayed by group 20 X 58 satellite array maximum

Update Time (NBS via modem)

Call the NBS via modem and update the computer clock
Setup modem parameters in NBSCOM.INI

TSR Status

Display the status of the OrbitDrv and RotorDrv TSR programs

compiled by Gould Smith, WA4SXM,

QuikTrak v4.0 Reference Sheet

"0"	key gets you out of the function
yellow text	satellite in view
white text	satellite not in view
"0"	key selects your QTH at the City Selection Menu
P	after the epoch date/time prompt will cause printing of the information
F	after the epoch date/time prompt will cause the information to be written to a file Remember to update the timezone parameter in QTH data editor after each standard/daylight change

SCHEDULE

AOS/LO	Acquisition of signal/Loss of signal
MAX	Time of maximum communication range for your location
DX/EL	Maximum elevation of the satellite this pass, * means pass doesn't go through apogee
AZ	azimuth at maximum elevation, best position to point if not tracking the satellite
P	key will startprinting of the schedule (printer does not start instantly)
F	key will store the data to an ASCII file SCHEDULE.DMP
1	key to clear the screen and start with date last on the screen
2	key will scroll the output until you hit the 0 key to stop it
7	key to display one more line of data

TRACK

Range	distance in meters to the satellite from the selected location
Ph	phase - the MA of the satellite
Md	mode - the current mode, this depends upon correct data in Mode String
PA	pointing angle, what angle the antenna are pointing away from the selected city this is determined from the data in the ALAT/ALON field of the element set
E	eclipse, is the satellite in eclipse? 1 = yes, 0 = no
V	visible, present if the satellite is probably visible to the naked eye
Dop.	Doppler shift, Freq String (1)/(2) information necessary to compute
ES	1/2 the angle subtended by the earth as viewed from the satellite
SSE	Sun, Satellite, Earth angle, ES and SSE used to determine eclipse
8	key displays mutual visibility times between selected location and 14 cities
NIV/SIV	Never in View / Still in View
AOW/LOW	Acquisition of Window, Loss of Window
P	key will start printing of the schedule (printer does not start instantly)
F	key will store the data to the ASCII file TRACK.DMP

MUTUAL WINDOW

AOW/LOW	date/time of Acquisition of window / date/time of Loss of window
Dur.	duration in minutes of the mutual window
MA0 MA1	phase(MA) at beginning of window, phase(MA) at window end
MinSQA	the time of minimum squint angle for both stations
MinRNG	the time of minimum range between the stations and the satellite
SQ0 SQ1	minimum squint angle during window of location #1 and location #2
PH_S	Phase at the sum of minimum squint angle (MinSQA)
PH_R	Phase at the sum of minimum range (MinRNG)

REALTIME 1 SAT (tabular)

a	autotrack toggle, if on and working an "A" displayed in upper right of screen
G	Gather, allows collection of telemetry via serial port, run MBBIOS, data in file TMPDATA
c	displays the full cartesian coordinates and velocities of satellite and observer
r	Right Ascension and Declination display of sat from your location, for visual sighting
s	search for AOS/LOS and display time and duration
d	input a time for minimum waits between outputs
i	display the full updated orbital elements as the orbit changes
S	Select a new satellite

REALTIME 1 SAT (graphics)

r	range circle, toggles the satellites' footprint on the globe
a	autotrack toggle, if on and working an "A" displayed in upper right of screen
d	toggles the terminator or grey line, area illuminated by the sun
f	fast, speed the clock up one time unit per press - 10 sec, 1 min, 10 mins, 1 hour
s	slow the time one time unit per press, the opposite of the "f" key
o	old, returns the clock to realtime
g	groundtrack, draws a groundtrack of subsatellite point, use with "f" and "s" keys
z	zoom in on the subsatellite point
spacebar	pauses the display, press again to restart

REALTIME MULTISAT (graphics and tabular modes)

graphics	mode cycles through all satellites, flashing the appropriate + marker, same display as Realtime 1 Sat
tabular mode	lists tracking information and time to AOS/LOS of 14 satellites *** very useful
AOS/LOS	Acquisition of signal/Loss of signal
spacebar	pauses the display, press again to restart

MUTIOBSERVER 1 SAT

	displays satellite output as in TRACK function, but gives EL/AZ/Range for all cities in the city file
d	delay, allows you to set the minimum delay between screen fulls of data

EQX/APOGEE

	lists equator crossing times for LEO satellites or apogee times for Phase III satellites
f	stores (appends) data to file EQXAPO.DMP

VISUAL OBSERVATION

	makes a list of passes that should provide visual observation of the satellite
L.S.T.	Local Sidereal Time

DUMB TERMINAL

	You are prompted to program the COM port, as COM1:4800,E,7,1
CTRL/E	ends this function, ALT/E causes typed keys to echo, CTRL/C is disallowed as input

DATA EDITOR - KEPLERIAN FILE EDITOR

Satellite Name:	must match AMSAT/NASA spelling and case; use a " . " for null satellite
Satellite ID:	not required
Freq String (1):	Beacon frequency used for mode selection and doppler calculation
Freq String (2):	day codes or modes, as X145.25,H435.025,S2405.,B145.812
Blat/Blng:	must be Stabtype 0, used for pointing angle, BLAT/ALAT and BLON/ALON
Mode String:	string from which current mode is displayed, uses Freq String & Modetype
if **Modetype 0**	three digit phase value(start @ 000), then one phase letter as 000O030B165J195S205B = 0-30 off, 30-165 B, 165-195 J, 195-205 S, 205-255 B
if **Modetype 1**	seven letter day string encodes the mode SUN - SAT as XXXHXXS means 145.25 SUN-TUE, 435.025 WED, 145.25 THU-FRI, 2405 SAT
Stabtype:	0 = spin stabilized (as AO-10, AO-13), 1 = vertical stabilized by magnets and/or gravity gradient booms (as UO-11, FO-20, RS-10/11)
Modetype:	0 = modes determined by phase, 1 = modes determined by day of week

DATA EDITOR - QTH DATA EDITOR

Latitude N.:	+ decimal degrees North of the equator
Longitude W.:	+ decimal degrees West of Greenwich
Height Mtr.:	height in meters of your QTH
CH. AN.:	change in your antenna angle, how may degrees before updates
Lines/Page:	the number of lines per page for your printer, to control form feeds
Time Zone:	computer clock time zone, 3 letter timezone + number of hours to add to your time zone to equal UTC, as EST5 Eastern Standard adds 5 hrs, EDT4 Eastern Daylight adds 4 hrs

compiled by Gould Smith, WA4SXM,

by just sitting down at your computer and trying some of these features. You may even be inspired to read the manual. There are some very good explanations and theory behind many of the available features. Take a little time, have some fun and learn something new. All four of these programs display the pointing angle, provide for automatic element updating and will print a tracking chart. Here are my favorite features in each of the tracking programs:

InstantTrack v1.

by Franklin Antonio, N6NKF

Very fast, great graphics, 7 selected satellites status displayed at the bottom of many screens, view from the satellite, 1754 city data base, mouse activated city display, cursor key switching between satellites, online help, satellite grouping, satellite visibility graph, ease of ordering satellites using ITSORT, current mode display

QuikTrak v4.0a

by Bob McGwier, N4HY

One line satellite schedule with max elevation to disk or printer, current time to AOS/LOS of 14 satellites display, excellent graphic display, mutual window schedule, incremental time speed up, draws a ground track, visual observation indication

Orbits III v4.01/II v4.02

by Roy Welch, W0SL

Multiple satellite graphic display and labeling, satellite grouping, ease of adding a satellite. ■

Gould Smith, WA4SXM, has been a ham for 17 years and has been interested in Satellite Operation for 3 years. He is the Author of the authoritative Decoding Telemetry From the Amateur Satellites published by AMSAT. Professionally he is a software engineer for Philips Consumer Electronics.

Decoding RS 12/13

(continued from page 14)

is no 2M transmitter output power and in Block 4 there IS 15M receiver AGC (QED... Mode "K"!).

Teachers and Educators Take Note!!!!

Another group that would really benefit from decoding simple satellite telemetry would be High School and Jr. High science classes. What better way to introduce young people to science, space, and Amateur Radio than to have a group of students copy and keep records of the telemetry of an Amateur satellite! The equipment is minimal and they couldn't help but learn about orbits, receivers, transmitters, CW, and electronics. If equipment or time is a problem, a local Elmer could record the frames of data at night and give them to the instructor the next day. It would be fun and educational to chart the trends of the satellite for two or three months. If there is any interest in this, please let me know.

Other Sources of Telemetry Information

Perhaps the single best source of Amateur Satellite telemetry information is a book written by G. Gould Smith, WA4SXM called "Decoding Telemetry from Amateur Satellites". This publication is available through AMSAT and is advertised elsewhere in this publication. ■

Receive Only	Freq. Range (MHz)	N.F. (dB)	Gain (dB)	1 dB Comp. (dBm)	Device Type	Price
P28VD	28-30	<1.1	15	0	DGFET	$29.95
P50VD	50-54	<1.3	15	0	DGFET	$29.95
P50VDG	50-54	<0.5	24	+12	GaAsFET	$79.95
P144VD	144-148	<1.5	15	0	DGFET	$29.95
P144VDA	144-148	<1.0	15	0	DGFET	$37.95
P144VDG	144-148	<0.5	24	+12	GaAsFET	$79.95
P220VD	220-225	<1.8	15	0	DGFET	$29.95
P220VDA	220-225	<1.2	15	0	DGFET	$37.95
P220VDG	220-225	<0.5	20	+12	GaAsFET	$79.95
P432VD	420-450	<1.8	15	−20	Bipolar	$32.95
P432VDA	420-450	<1.1	17	−20	Bipolar	$49.95
P432VDG	420-450	<0.5	16	+12	GaAsFET	$79.95
Inline (rf switched)						
SP28VD	28-30	<1.2	15	0	DGFET	$59.95
SP50VD	50-54	<1.4	15	0	DGFET	$59.95
SP50VDG	50-54	<0.55	24	+12	GaAsFET	$109.95
SP144VD	144-148	<1.6	15	0	DGFET	$59.95
SP144VDA	144-148	<1.1	15	0	DGFET	$67.95
SP144VDG	144-148	<0.55	24	+12	GaAsFET	$109.95
SP220VD	220-225	<1.9	15	0	DGFET	$59.95
SP220VDA	220-225	<1.3	15	0	DGFET	$67.95
SP220VDG	220-225	<0.55	20	+12	GaAsFET	$109.95
SP432VD	420-450	<1.9	15	−20	Bipolar	$62.95
SP432VDA	420-450	<1.2	17	−20	Bipolar	$79.95
SP432VDG	420-450	<0.55	16	+12	GaAsFET	$109.95

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"A Really Great Regional Meeting"

By: Andy MacAllister, WA5ZIB
14714 Knightsway Drive
Houston, TX 77083
(713) 561-9691

Only a week after the 1991 AMSAT Annual Meeting and Space Symposium was held in Los Angeles, an AMSAT Workshop began at the Fort Worth Museum of Science and History. This Texas gathering was sponsored by the Southwest Dallas County Amateur Radio Club. Satellite enthusiasts from Texas and surrounding states attended.

The workshop featured talks by several speakers, included an evening banquet and a tour of the Soviet Space Exhibit. Microsat and RS-10 activity was demonstrated along with a successful two-way contact between U5MIR on the MIR space station and W5MIR in the Amon Carter Exhibit Hall. Although most local AMSAT groups may not be in a position to sponsor such an ambitious operation, it serves as an example of some of the things that can be accomplished by a dedicated and industrious group effort.

The Fort Worth Satellite Workshop

The Fort Worth workshop began Saturday morning November 16th with an introduction and welcome message from AMSAT Executive Director and Chairman of the Board, Doug Loughmiller, KO5I. Doug set the tone for the gathering and discussed the high points of the AMSAT meeting in Southern California. AMSAT's goals for the future with Phase 3-D were clearly outlined.

AMSAT Vice President of Operations, Keith Pugh, W5IU, presented a talk on "Getting Started in Amateur Radio Satellites". Keith has been active for many years on the satellites and had many slides and audio tapes in his demonstration.

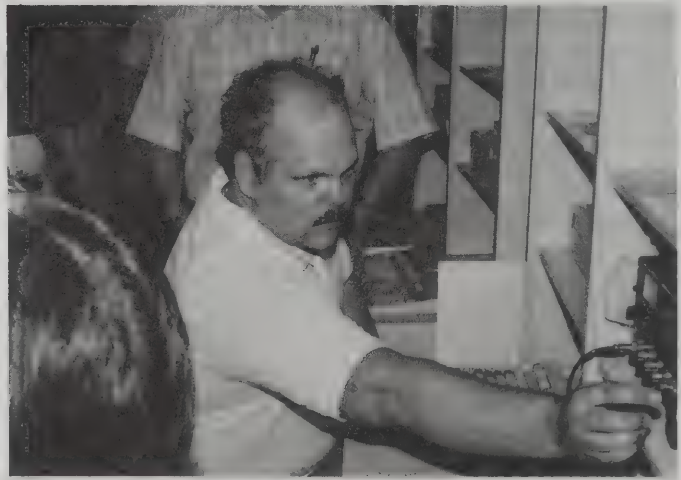
Tom Edmonson WB5DBF showed his video tape of microsat access techniques. The tape was later supplemented by a live demonstration at W5MIR in the exhibit hall. Tom's presentation provided potential users a much deeper understanding of system requirements from a "nuts and bolts" approach rather than magazine articles and books alone. The opportunity to ask questions and see it all work at a demonstration was a distinct workshop advantage.

Using slides by Lou McFadin, W5DID, AMSAT Vice President of User Services, Andy MacAllister, WA5ZIB, discussed the upcoming ham activities on board STS-45 and future Space Shuttle Amateur Radio Experiments (SAREX). This was a subset of the presenta-

"Mission Control" at the Soviet Space Exhibit in Fort Worth, Texas.

School children visiting the Soviet Space exhibit test their knowledge about space history with the specially programmed computers in the exhibit.

AMSAT Workshop participants crowd around the satellite station during the workshop in Fort Worth, Texas.



Tom Edmonson WB5DBF operates W5MIR during a microsat pass at the Fort Worth workshop. WA5JIB Photos.

tion given by AMSAT President Bill Tynan, W3XO, at the Los Angeles AMSAT meeting over the previous weekend.

Andy also passed around flight hardware from recent balloon launches by the South Texas Balloon Launch Team (BLT) and showed taped Amateur Television (ATV) footage transmitted from the BLT-4 launch of October 26th. He finished his portion of the workshop with notes on 9600 bps operation via UoSAT-OSCAR-14.

AMSAT Assistant V. P. of Operations for Orbital Data Management, Dick Campbell, N3FKV, provided the group with an in-depth description of orbital elements. His explanations took a lot of the mystery out of things like Right Ascension of Ascending Node and Argument of Perigee. Many satellite operators simply enter element sets into their computer programs without any idea of their meaning or significance. Dick put an end to a lot of misconceptions for those attending.

Following a brief break, Houston Area AMSAT Coordinator Allan Fox, N5LKJ, presented his shopping bag of mobile radios to the workshop. His talk focused on the ease of portable and mobile satellite activity using RS-10 with its Mode "A" (two meters up and ten meters down) linear transponder. Allan emphasized how easy it is to get involved with the amateur satellite program without a massive outlay of funds for exotic gear. He later proved his point with a contact via RS-10 from his truck in the parking lot.

During his talk, Allan also described his contacts with Musa, U2MIR, on the Soviet space station using only a handie-talkie. At that moment the squelch on his "HT" opened to the sound of Sergei, U5MIR, rising over the Fort Worth area. The workshop adjourned for the duration of the MIR pass while everyone listened on their own rigs to the contact taking place live between U5MIR in space and W5MIR across the street.

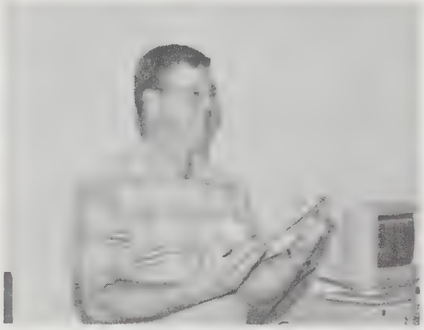
A question and answer period finished out the day's work. A lot of material had been covered in a short time and many participants had questions concerning their own specific situations and satellite systems. A door-prize drawing gave some of the participants books and other items to take home.

Dinner for participants and their families was scheduled at a nearby Tex-Mex restaurant. After the fajitas were eaten and the dinner discussions ended it was time to tour the Soviet Space Exhibit.

Sponsored by the Fort Worth Museum of Science and History Association, the Soviet Space Exhibit came to North Texas for six months between June and December, 1991. Major sponsors included many business and civic leaders in the North Texas area. One of the most notable was the Tandy Corporation. Their newest line of computers was featured in the "mission control" area. School-age

AMSAT Chairman of the Board and Executive Director Doug Loughmiller KO5I was first to talk at the workshop in Fort Worth.

AMSAT Vice President of Operations Keith Pugh W5IU provided information on getting started via the Hamsats while Tom Edmonson WB5DBF discussed introductory microsat activity.



Assistant V.P. of Operations for Orbital Data Management, Dick Campbell N3FKV, explained satellite tracking and orbital elements for the Fort Worth AMSAT workshop participants.

Houston Area AMSAT Coordinator Allan Fox N5LKJ provided insight on portable and mobile satellite operation.

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All active equipment - 13.8V

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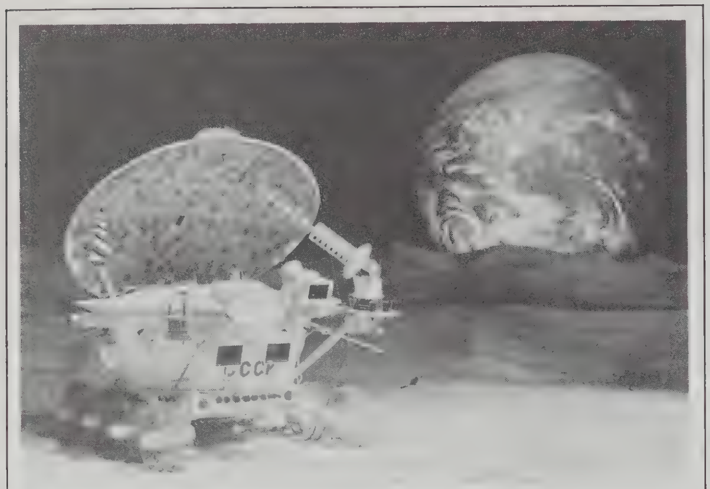
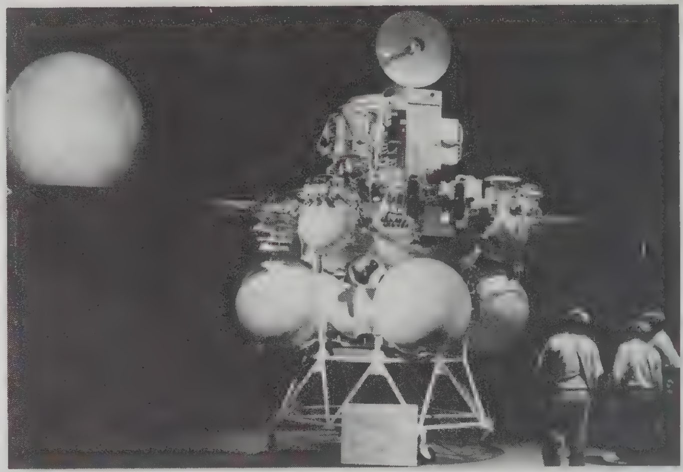

A full-scale working model of the Soviet Lunokhod 2 remotely controlled Moon rover was on display at the Soviet Space exhibit.


A full-scale engineering model of one of the Soviet Phobos spacecraft was on display at the Soviet Space exhibit in Fort Worth.

At the Soviet Space exhibit this RD-301 rocket engine prototype used liquid ammonia for fuel and liquid fluorine for the oxidizer.

children tested their knowledge of space history through a specially programmed quiz on one of the many S-VGA, CD-ROM equipped computers. Upon completion of the quiz they received personalized honorary cosmonaut certificates.

The North-Texas AMSAT group provided volunteers and equipment for a complete satellite station at the site for the six-month period. Even with long coax runs, quality AMSAT-OSCAR-13 contacts were possible along with Microsat work and MIR QSO's.

The North-Texas AMSAT group has organized gatherings in the past. The theme of their January, 1991 workshop emphasized a "hands-on" approach with a complete satellite station operating through the night. The latest one will be hard to match or exceed, but it was certainly worth the effort. Other groups around the country have also done well with satellite forums and presentations.

Expanding talks to local clubs to include two or three speakers with expertise on specific hamsat topics is a good place to start. From there the same principle can be used at local ham conventions providing interested amateurs with several satellite-oriented sessions. An operational satellite station in the parking lot or swapfest area adds to any talk or presentation. Using topics like those presented at the Fort Worth workshop provides something for everyone.

Going all the way to a workshop event requires planning. Finding a location, getting speakers and advertising the activity requires a dedicated group of volunteers. The event could be held at a local school or community college. The results can be quite satisfying and provide the impetus to many new satellite enthusiasts to become active via this high-tech facet of Amateur Radio. ■

AMSPEC-3:
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WINDOW
INTO SPACE!

AMSPEC-3

A DIGITAL SPECTRUM MONITOR
DESIGNED EXCLUSIVELY FOR
AMATEUR RADIO OPERATION

You can **HEAR** the OSCAR satelities - now **SEE** the signals too! Not just another spectrum monitor, AMSPEC-3 by Mauro Engineering has advanced features you would expect only in a much higher priced instrument.

USE THE POWER OF YOUR PC OR COMMODORE 64 FOR DSP (Digital Signal Processing) to display those weak satellite signals. And the 70dB dynamic range of AMSPEC-3 makes it a joy to use in strong adjacent signal environments.

THE UTILITY OF AMSPEC-3 DOESN'T END WITH SATELLITE USE - works great on HF and it's a natural for the test bench.

SPECIFICATIONS: ** frequency range 1.8 to 31.0 MHz - VHF/UHF coverage with receive converter ** sweep width 250 KHz in spectrum mode ** sweep rate 6 sweeps per second in direct mode - 3.5 seconds for one sweep in long signal averaging mode ** circuitry features dual conversion superhetrodyne design using double-balanced mixers ** sensitivity greater than 1 uV MDS ** 500 Hz resolution **

TO GET THE FULL STORY ON AMSPEC-3 send a business size SASE with two units postage. You'll receive a four page write-up with photos describing satellite use and minimal station requirements. Also included are all current application notes.

PRICE RANGE: PC and Compatibles - $299.00 ** Commodore 64 - $229.00
Plug-in power supply - $10.00 ** Splitters available
(Prices subject to change without notice - Calif. residents add sales tax)

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Microsat Gateways Abound

[After a modest start in bridging packet networks in Alaska and the USA, the AMSAT Packet Gateway System now spans the world. 24 gateways are now in daily operation and about 100 pieces of traffic are handled daily.]

By: David Medley, KI6QE
1450 Bayview Heights Drive
Los Osos, California, 93402

In the May, 1991 *The AMSAT Journal*, John Lawson, NL7NC, described a project that he and I undertook to alleviate the problem of transferring packet traffic from the Alaskan State System (AKNET) to and from the main US Networks in the lower 48 States. HF had been used for a number of years and had not proved successful because of its unreliability particularly in high latitudes.

As a result of discussions with Courtney Duncan, N5BF, at that time AMSAT VP Operations, it was proposed to use PACSAT as a supplement to HF. Preliminary tests in January, 1991 indicated that this was quite feasible. At this point Courtney contacted me and asked whether I would work with John on this project. I readily agreed because it sounded interesting, challenging and a useful service to ham radio. The AMSAT Satellite Gateway Experiment was born.

John was an experienced BBS operator and I had been experimenting with the Microsats from the day they were launched. Between the two of us we had the necessary knowledge and experience to put the two together. I also had the support and encouragement of a long time BBS operator Mac, AA6QD, who has operated for many years a BBS hub in Central California with telephone as well as VHF/UHF links. Mac's BBS covered the USA and was a wonderful vehicle through which to start the Satellite operation.

To start the system in the simplest way possible Mac loaned me a PacComm Tiny-2 TNC with a Personal Third Party Mailbox built in. This was hooked up to a Yaesu FT727 HT and AA6QD included KI6QE on his regular forwarding schedule. I manually placed messages in and read messages from the Tiny-2 and uploaded/downloaded to PACSAT daily. This was fun and something new and traffic began to increase slowly. Soon we were joined by VE8DX in Baffin Island in the Canadian Arctic who found this a great way to communicate with some of his friends in the USA.

The system was so successful that soon others began to notice what was going on and started asking to send messages overseas. Others asked to use the system to cut down the time for east-west US traffic. It was then that I became the Coordinator of the Gateway Experiment. I began to solicit gateways wherever I could find them and to develop some organization and documentation to be sure we were all following the same format. This makes it easier for the users so that the procedure was the same everywhere. We were quickly joined by John, WA0PTV, in Fredonia NY, Tom, EI6EH, in Kells Ireland, Renauld, ON4KVI, in Belgium and Denis, SV8RV, in Greece.

The Tiny-2 at KI6QE quickly became inadequate and I started experimenting with various BBS systems including W0RLI, AA4RE and MSYS but none of these quite did what I wanted. During a discussion on this subject Tom, EI6EH, suggested I try the F6FBB French system and so I wrote Jean-Paul, F6FBB, and obtained the latest version. This was installed on an old IBM PC 6MHZ computer. After some initial troubles it has been in operation ever since and more and more gateway operators are using it.

The system today at KI6QE is totally automated in all respects and more will be written about this in the near future. The Satellite Gateway Experiment now includes 24 stations with more to come. The total list and the present coverage can be found in Table 1.

The operation of the gateways is coordinated and all operate in accordance with the following rules.

Gateway Operation

Gateway Operators agree to access the Primary Satellite at least once per day to download and upload traffic. In the event that they are not able to do this due to vacations, business, health or any other reason KI6QE should be advised. KI6QE will act as general coordinator of the experiment and will respond quickly to any questions, problems etc. It is important to handle traffic in a timely fashion in order to demonstrate the value of this mode of communication to users throughout the world.

Auther Dave Medley, KI6QE, in his operating postion.

Primary and Secondary satellites vary from time to time in accordance with their operational status. A Satellite Use Bulletin is posted regularly on the satellites. A typical Bulletin may take the form:

PRIMARY	SECONDARY	BACKUP
UO14	LO19	AO16
LO19	AO16	FO20

NOTE: Gateways with 9600 baud capability use UO14 as primary.

File Naming Convention.

All files uploaded to the satellite should comply with the following format before compression (ZIP):-

AABBCCTS.IN

where: AA = Origin Designator
AK = Alaska
CA = California (Western States)
NY = New York (Eastern States)
EI = Ireland (Ireland, UK, Scandinavia)
EA = Spain (Spain,Portugal, Italy, S.France)
TX = Texas (South Central States)
etc.

BB = Day of the month

CC = Message Serial Number

T = Type of Message
  T = Regular Message Traffic
  A = Service Messages
  N = NTS Traffic
  B = Bulletins

Modest antennas are all that is required.

S = Satellite to be used
1 = UO14
2 = LO19
3 = AO16
4 = FO20

Be sure the extension (EXT) .IN is included to facilitate inward traffic handling at automated gateways. All gateways are encouraged to use the same convention in their software. Long files should be compressed (ZIPPED) before uploading particularly if PACSAT or LUSAT are to be used.

Restrictions

Please note that NTS type traffic is accepted only for delivery within the USA generally. There may be other countries which permit this and it will be up to each individual gateway operator to insure his local regulations are complied with.

The transmission of Bulletin type traffic must be restricted to bulletins of general information such as AMSAT,KEPS,RTTY,DX etc.

FOR SALE, WANTED and similar type traffic will not be uploaded to the satellite and gateway operators should be especially careful on this point.

Messages in languages other than the mother tongue of the gateway operator are left entirely to the discretion of the particular gateway operators involved. Just remember that PRIVATE messages are the only ones permitted and that no commercial content of any kind should be transmitted. Contrary to the attitude of many BBS operators KI6QE has encouraged the use of foreign languages as a matter of courtesy and more importantly to foster International friendship and understanding. About 30% of traffic through KI6QE is in languages other than English.

All are encouraged to experiment with traffic handling and interfacing with the terrestrial networks. Software development is particularly important and please share your work and views with all of us.

Typical Modus Operandi

As an example, the operation at KI6QE involves the following:

a. An F6FBB private BBS which regularly reverse forwards to a large public BBS before and after satellite passes. This BBS also operates from 0000z to 1800z daily for direct access.

b. Inward traffic, after de-heading and unzipping and with the EXT .IN is placed in a mailbox MAIL-IN.FBB. The BBS accesses this mailbox regularly and transfers the inward traffic to the BBS for forwarding.

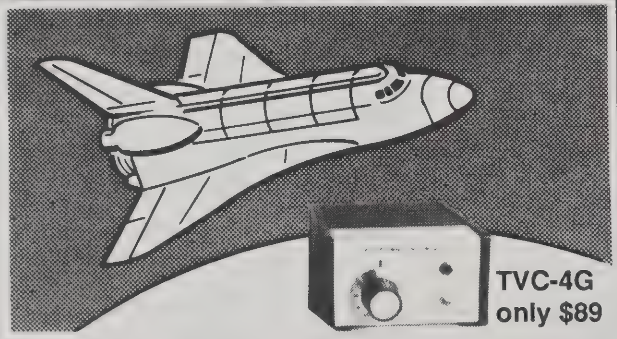
c. Outgoing traffic is forwarded by the BBS to separate mailboxes, one for each gateway. Files are consolidated into one file during this operation. Before the satellite pass, consolidated traffic is taken from each mailbox, compressed (ZIP) and prepared for uploading (PFHADD).

d. Software for satellite access is based on the PE1CHL.NET program which takes care of Directory, Uploads and Downloads automatically and in one pass.

e. Both the inward and outward traffic handling at KI6QE is now completely automated using the PE1CHL.NET software and the F6FBB BBS system. Complete details of this will be published at a later date.

Please let us have any comments/suggestions on the above. Attention is drawn to the F6FBB software which has paid more attention to automation than other BBS tried at KI6QE (AA4RE,W0RLI,MSYS). The automatic compressed forwarding is also a unique feature and some terrestrial BBS SYSOPs who interface with gateways are already using this with 9600 baud and HF terrestrial systems.

My personal thanks to all of you for joining in with this project. I appreciate the enthusiasm and assistance which has been generated. ■



AMATEUR TELEVISION

SEE THE SPACE SHUTTLE VIDEO

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P.C. ELECTRONICS
Tom (W6ORG)
Maryann (WB6YSS)
2522 S. Paxson Ln Arcadia CA 91007

TABLE 1

GATEWAY	LOCATION	COVERAGE
KI6QE	Los Osos CA	Western United States and Canada
NL7NC	Anchorage AK	Alaska
VE8DX	Baffin Island	Baffin Island only.
WA0PTV	Fredonia NY	N. England States and E. Canada
KF4WQ	Lumberton NC	Carolinas, SE USA
LU8DYF	Buenos Aires	All South America
ON4KVI	Vielsalm Belgium	Western Europe
ZS1ABM	South Africa	South Africa
JA6FTL	Japan	Japan, Taiwan, Singapore, Phillipines, Hong Kong
W0SL	St Louis	Central USA
ZL2AMD	Napier NZ	New Zealand
EI6EH	Kells Ireland	Ireland,United Kingdom, Scandinavia
EA8RT	Barcelona Sp	Spain,Portugal,S.France, Italy, N.Africa
OH6KG	Karleby Fin	Finland,Sweden
NU9H	La Porte IN	N. Central States, Central Canada
NR3U	Selingsgrove PA	Atlantic States
W5ERO	Lubbock TX	South Central States
KG4TM	Guantanamo Bay	Caribbean Region
EA6IC	Malloca Is	Western Spain
SV8RV	Zakynthos Greece	Eastern Europe, Israel, USSR
YB0QC	Jakarta Indo	Indonesia, SE Asia
VK5ZK	Adelaide SA	Australia

LU7ABF and LU1EDY also supplement LU8DYF in serving South America.

Apogee View

(continued from page 3)

AMSAT Journal, contributors will be the ones who receive these more detailed up-to-the-minute reports.

Still on a good news roll, response to the Phase 3D fundraising letter is going well as this is being written New Year's Eve. It's a good thing too. Yesterday, I gave Dick Daniels, our Phase 3D Project Manager, the go-ahead to order about $8 thousand worth of aluminum for fabrication of the very critical adaptor rings. Actual fabrication is another matter. That will cost another estimated $70 thousand! But; these activities, along with the fine design work that Dick Daniels, Dick Jansson and the rest of our Phase 3D team have accomplished so far, means that our part in the Phase 3D Project is off to a good start. Your further response to the Phase 3D fund raising plea will insure that this trend continues.

Also in the good news department is the performance of the Microsats. PACSAT, AO-16, is performing as intended and is seeing increasing use as a store and forward message handler. LUSAT, LO-19, is also reportedly performing normally. The folks at Weber State are continuing the picture taking and other activities of WO-18. The DOVE situation is so complex and fraught with controversy that it will be addressed separately from the other Microsats.

Another candidate for characterization as good news has been the fine appearance and timely production of *The AMSAT Journal*. We have always had a problem with publications in the past, but thanks to Drew Deskur KA1M and his crew, these difficulties seem to be behind us. But, Drew would be quick to add that we still need good articles. So; take pen, or keyboard, in hand and let the rest of the AMSAT members in on your particular pet piece of hardware or software.

In the not so good news department is the situation with respect to AMSAT's finances. Partly as a result of carrying two full time employees, our fund balance, equivalent to net worth, has be been dropping steadily and much too rapidly. We must do something soon, or the very existence of our organization will be threatened. I will soon be announcing two initiatives to help stem these losses. One will be a drive for new members, possibly taking the form of a contest. If we can double our membership (every member convince just one friend to join) we can reach a point where economies of scale begin to kick in. We can also attract more advertisers to *The AMSAT Journal*. With our present circulation, most firms which advertise are merely making a contribution. Believe me, we appreciate their support. But, with twice our current circulation, we become an attractive advertising medium for many Amateur Radio related products and services. The other initiative will be a campaign to get regular members to sign up as Life Members. Life Members do not require annual renewal notices and, in many cases, follow-up notices. Sending out these notices is expensive and time consuming, taking Martha's time away from performing other services for the members. So, if you are not already a Life Member, please consider becoming one soon. The dues are $650 payable in four installments over one year.

As to the future. The coming year promises to be a very productive one for continued progress on Phase 3D, SAREX and other AMSAT programs - provided that contributions and pledges for Phase 3D continue to pour in and AMSAT can about double its current membership plus sign up a substantial number of Life Members. We are well aware that these are tall orders in the light of the current situation with the economy. But, if you are still working, or otherwise have a steady income, please consider devoting some of your hard earned money to the organization that put Amateur Radio back into space twenty years ago and pledges to keep it there well into the next century.

I want to separately address the situation with respect to DOVE. The detailed chronology of this is covered in a separate article by Harold Price and Bob McGwier. (See Page 15.) However I do want to add a few commments of my own.

Anyone who believes that AMSAT Officers and Board members have not been sensitive to our failure to get DOVE performing as originally intended, are sadly mistaken. We are only too well aware of the disappointment this has caused and the damage it has done. Why has this unfortunate situation persisted and why has there not been more information forthcoming as to the status of efforts to makeDOVE operational?

The first part of this question is best answered in the aforementioned article by Bob and Harold. I will attempt to answer the second part of the question in the following paragraphs.

I believe that most have been aware of early history. They know of the rescue of DOVE by W5UN and his 2 meter EME station, referred to in the separate article. As to more recent history, I submit that ANS bulletins up through last fall carried a considerable amount of information on DOVE status. Lengthy bulletins went into considerable detail when Harold completed the software needed to operate the satellite. Once the software was created, the task of loading was undertaken by Bob. The reason he was the right one for this task is because he worked closely with Harold on the creation of the software and the job of loading it requires someone intimately familiar with it. Then, as detailed in the article by Harold, the loading job was complicated by the fact that the S-Band transmitter on DOVE has never performed as it was supposed to. This hardware failure prevented the intended hand shaking between the computer on the ground, sending the necessary instructions, and the computer aboard the spacecraft. As noted in the article; initially Bob's S-Band receiving equipment wasn't up to the job of copying the weak signals from DOVE's failed S-Band downlink, requiring him to work with people hundreds of miles away via long distance phone. This arrangement was less than satisfactory for various reasons. This necessitated an upgrade to Bob's stations which Junior DeCastro PY2BJO largely funded. The equipment was supplied, on very short notice, by Bill Olson W3HQT of Down East Microwave. Doug Loughmiller KO5I spent a week at Bob's QTH helping install the new equipment. While worthwhile, this was but one of the many things Doug did for AMSAT that took time away from fundraising.

Once the software was available and N4HY's station performing properly, the job of actual loading began in earnest. The first step in this process was a return of DOVE to 145.825 MHz so that data on its performance could be gathered. This, Bob achieved in early fall. Once again, this was fully documented in ANS bulletins at the time. Naturally, everyone, including Bob, was confident that DOVE would be talking soon. Optimism is always a characteristic of volunteers. What Bob didn't count on were world shattering events in eastern Europe. As a top analyst for a firm under contract to the U.S. Government, he is on call at all times. And when he is called, he is out of reach for whatever time is required. Anyone who reads newspapers and watches news on television should not be surprised that this is exactly what happened in late fall - torpedoing all good intentions to have DOVE on the air by Christmas. To those who ask why information was not forthcoming on the delay in schedule, I can only say that neither I, nor other AMSAT Officers knew where Bob was, what he was doing or how long he would be gone. No one would have been impressed by an ANS bulletin saying "N4HY is away and we don't know when he is coming back".

I did know of Bob's absence, and I would have been happy to discuss the situation, as I understood it, with anyone who had cared to call me. Rather than doing this, one prominent individual; who happens to be a member of our Board of Directors, and thus should have known where and how to get information; choose to publish an editorial in an Amateur satellite newsletter, impugning the sincerity and competence of "AMSAT-NA management". He even extended his criticism to our participation in the Phase 3D Project by quoting statements from alleged "readers" to the effect that they plan to "ignore" AMSAT's recent Phase 3D fundraising appeal "until they have more confidence that the funds will be effectively expended" I consider this use of unattributed comments from "readers" as an open attack on AMSAT, its Officers and it's participation in the Phase 3D Project. The space programs of all countries, which have them, are littered with failures. I hasten to emphasize that DOVE is not a failure yet. As I write this, efforts continue to make it fully operational; although the destruction of N4HY's antenna system in an early January storm, hasn't helped this process. Because of failures, the Soviets and the U.S. have some dead cosmonauts/astronauts. NASA is still struggling to get Hubble functioning as planned. It will even spend $30 million plus to send up a repair crew to get the job done. I could cite countless other failures, and they didn't come from organizations employing unpaid volunteer help.

I submit that such open condemnation of AMSAT in the public press, especially by an AMSAT Board member, has done the Amateur Space Program a grave disservice. I would have been, and still will be, happy to talk to anyone who has questions about DOVE, Phase 3D, or any other issue concerning our organization. Anyone may call Martha, and she will make whatever arrangements are appropriate so that we can discuss the matter.■

AMSAT News

Hamfest season is upon us

Believe it or not - it is not too early to start planning your AMSAT Hamfest activities. AMSAT HQ can provide you with handouts, banners, along with software and publications to sell. It is just this sort of grass roots support that gets the word out to potential new members and keeps AMSAT alive. Get one or two of your local AMSAT friends and plan to bring AMSAT out to all those potential new AMSAT members.

Phase 3D Fundraising Campaign Has Begun

If you have been reading the articles here in *The AMSAT Journal*, you know that our latest project, Phase 3D is the most technically complex effort to date by any group of volunteers. Not only will it tax the collective technical resources of AMSAT but the estimated outlay of $4 million will tax the financial resources of AMSAT. AMSAT NA is committed to providing $1.5 million of that total. WE NEED YOUR SUPPORT. AMSAT Chairman of the Board and Executive Director Doug Loughmiller, KO5I, sent a letter to every AMSAT member to explain in detail how important this project is and how important your donation is - no matter the size. Please consider signing onto the team that gets Phase 3D into space.

ATARI-ST Program Available

Roy Welch, W0SL, the AMSAT Software Exchange Manager, announces the addition of a tracking program for the ATARI-ST computer. It is called "Satellite Prediction Program" by Bill Penner, WB7DPF. We wish to thank Bill for his permission to distribute this program. We also want to thank Ray Antasek, WA6TKV for reproducing and labeling the copies for AMSAT Headquarters. Those wishing to obtain this program may call Martha at the AMSAT office.■

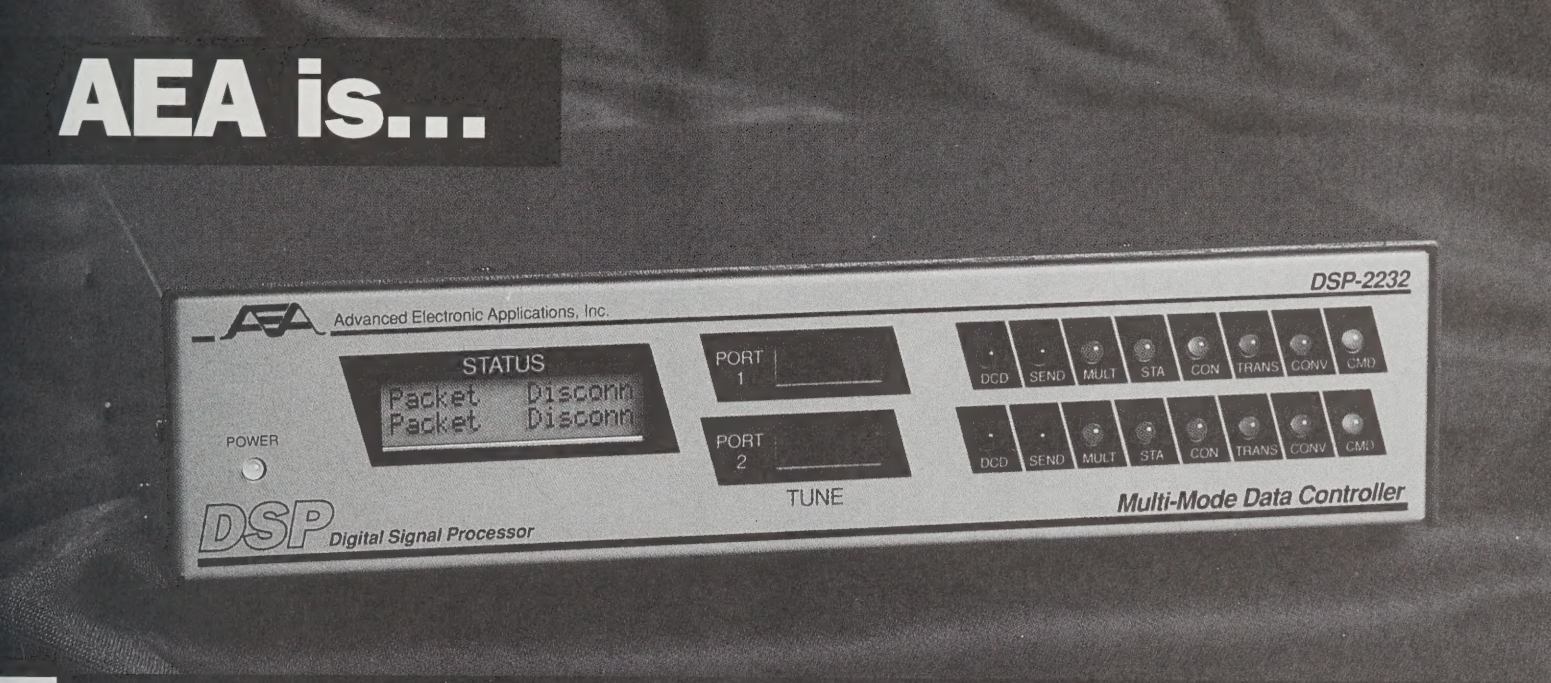
Satellite Orbital Elements

By Dick Campbell, N3FKV

Satellite	**AO-10**	**UO-11**	**RS-10/11**	**AO-13**	**FO-20**	**AO-21**	**RS-12/13**
Catalog Number	14129	14781	18129	19216	20480	21087	21089
Epoch Time	92035.34737257	92307.56984568	92037.40951254	92035.72986049	92014.83021608	92038.09633531	92036.09763206
Element Set	795	170	34	337	290	233	193
Inclination	26.0931	97.8672	82.9232	56.889	99.0604	82.9423	82.9266
RAAN	100.0032	78.5841	245.7587	44.8598	322.1087	59.9377	291.4423
Eccentricity	0.6071096	0.0012507	0.0010317	0.7286905	0.0540542	0.0035974	0.0030459
Arg of Perigee	316.486	138.6966	254.0197	277.1521	182.0931	327.0272	353.9254
Mean Anomoly	9.4562	221.5184	105.9835	12.4683	177.7899	32.8643	6.154
Mean Motion	2.0588612	14.68106028	13.72253491	2.0970132	12.83199781	13.74452087	13.73962926
Decay Rate	-9.000E-07	4.228E-05	1.750E-06	-1.068E-05	1.900E-07	1.520E-06	1.410E-06
Epoch Rev	3702	42382	23171	2790	9070	5129	5012

Satellite	**UO-14**	**AO-16**	**DO-17**	**WO-18**	**LO-19**	**UO-22**	**MIR**
Catalog Number	20437	20439	20440	20441	20442	21575	16609
Epoch Time	92036.75590866	92038.17796152	92038.21197876	92038.24762946	92036.38959288	92037.12855321	92037.55883736
Element Set	501	401	399	399	398	106	55
Inclination	98.647	98.6556	98.6552	98.6515	98.6554	98.5273	51.5985
RAAN	119.6691	121.5829	121.7039	121.787	120.0356	13.9426	189.017
Eccentricity	0.0010213	0.0010081	0.0010659	0.0011873	0.0010633	0.0008315	0.0014312
Arg of Perigee	102.7031	196.3526	195.4944	193.7517	202.9418	343.364	119.2101
Mean Anomoly	157.3695	163.733	164.5923	166.3339	157.1411	16.7328	240.9767
Mean Motion	14.2948676	14.29555888	14.29668157	14.29684426	14.29753299	14.36458196	15.61341199
Decay Rate	1.734E-05	8.820E-06	9.220E-06	1.581E-05	7.870E-06	1.208E-05	5.219E-04
Epoch Rev	10635	10656	10657	10658	10632	2929	34173

AEA is...


DSP-2232
Advanced Electronic Applications, Inc.
STATUS
Packet Disconn
Packet Disconn
POWER
PORT 1
PORT 2
TUNE
DCD SEND MULT STA CON TRANS CONV CMD
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Packet...plus!

If you want the best Packet or multi-mode equipment available, look no further. These data controllers have no equal when it comes to features, performance and value.

The versatile DSP-2232 (above) is simply the most powerful multi-mode controller available to amateurs. It features Digital Signal Processing modems, dual simultaneous ports, all known amateur digital modes, Packet and AMTOR mailboxes, and much more.

The legendary PK-232MBX (top right) has long been the most popular data controller ever, and is still going strong. Includes: Chebyshev filter design, Host Mode, Signal Identification mode and more. With features like these, no wonder it's number 1.

For Packet only, the PK-88 (center) and its PC-compatible plug-in counterpart, the PCB-88 (bottom right) offer AEA's famous Host Mode, Packet maildrop, KISS mode, lithium battery-backed RAM...the list goes on and on.

When hams think of Packet, they think of AEA.

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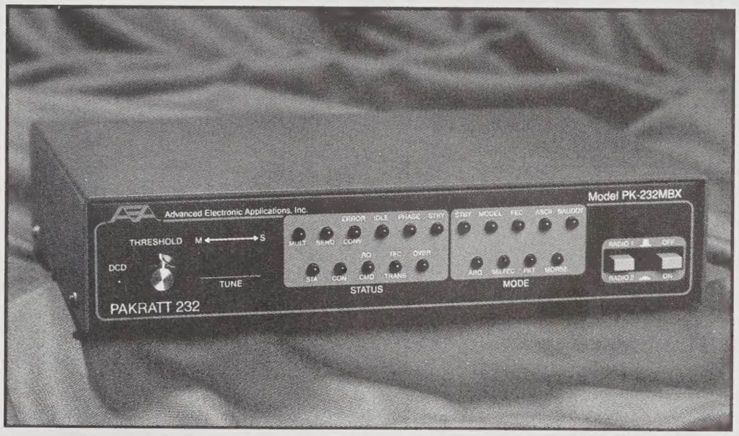
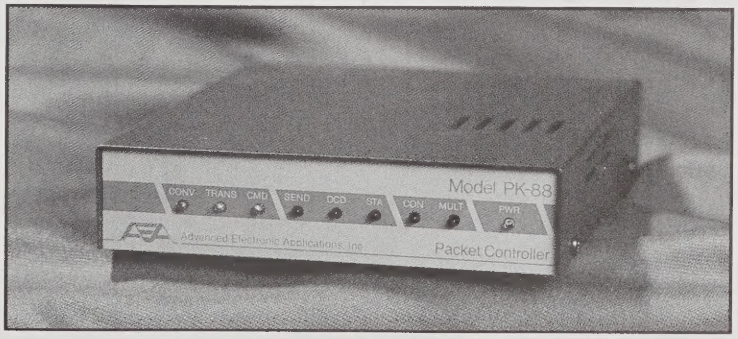
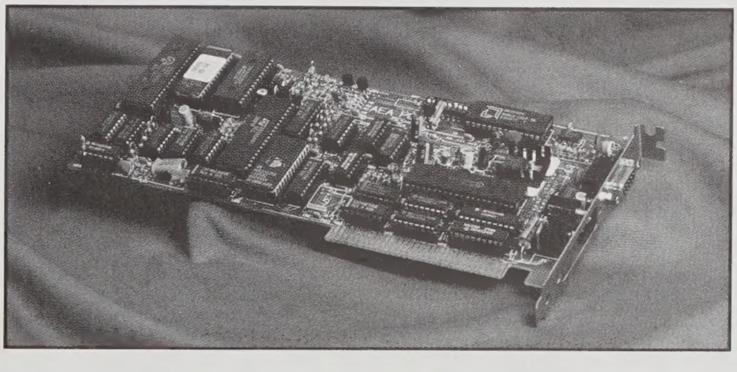



Model PK-88
CONV TRANS CMD SEND DCD STA CON MULT PWR
Advanced Electronic Applications, Inc.
Packet Controller



WORLD CLASS PERFORMANCE

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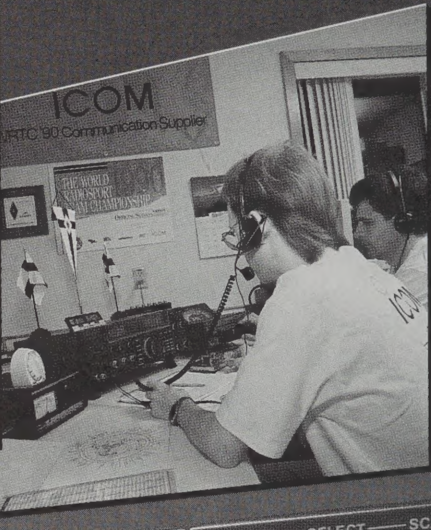
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Team Finland
in operation:
Jukk Keshiaho
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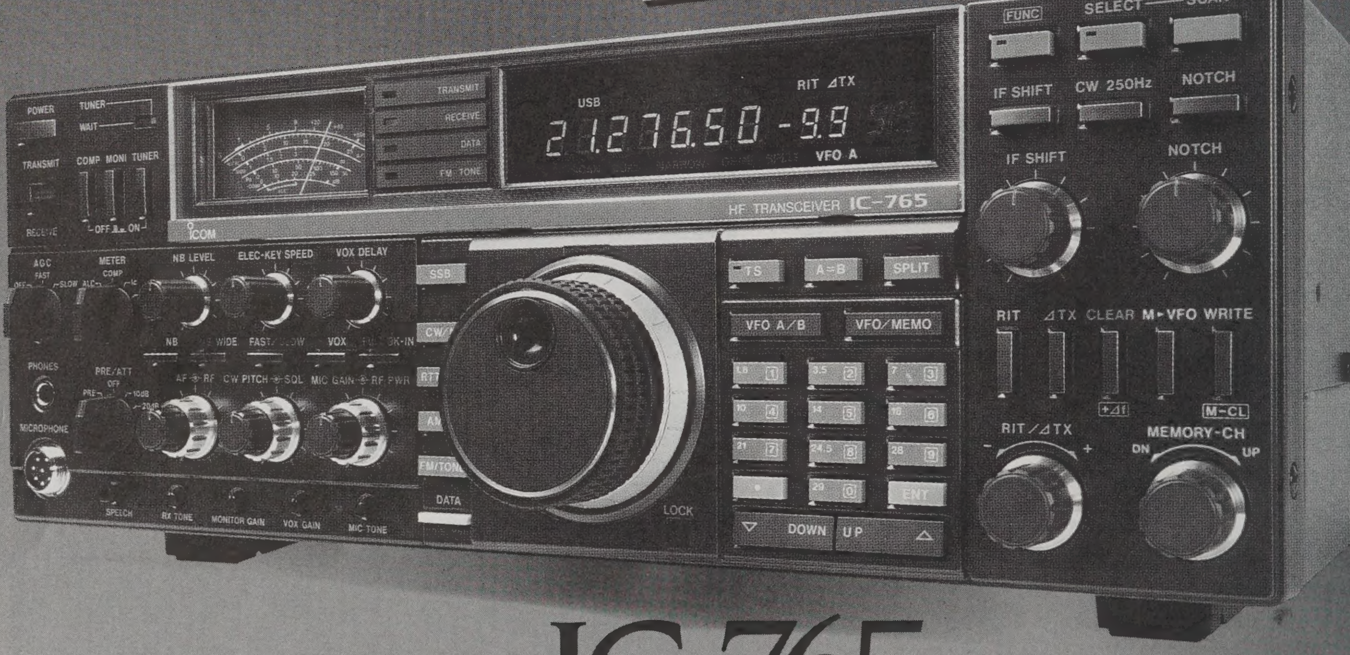

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HF TRANSCEIVER

Selected as the official radio of the World Radiosport Team Championships, a cultural exchange event of the 1990 Goodwill Games™, the IC-765 exemplifies ICOM's commitment to excellence in performance. The IC-765 incorporates the finest technology with the best designs to produce unbeatable HF operation for competitors worldwide.

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The IC-765 general coverage receiver covers all bands and all modes.

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